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GEOLOGICAL INVESTIGATIONS OF CHROMITE IN CALIFORNIA

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CHAPTER 3

CHROMITE DEPOSITS OF TULARE AND EASTERN FRESNO COUNTIES, CALIFORNIA

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ABSTRACT

The chromite deposits of Tulare and Fresno Counties have yielded approximately 24,760 long tons of lump ore and 1,090 long tons of concentrate of which 4,535 tons came from deposits in Tulare County and all but 90 tons of the remainder came from deposits in the eastern part of Fresno County. Chromite mining in the counties was most active during World War I; no chromite ore has been shipped from deposits in Tulare County since 1919, and only 2,350 long tons was shipped from deposits in Fresno County from 1919-45. A small chromite mill in Fresno County was operated intermittently from 1941-45.

Most of the chromite deposits found were small, and only six contained more than 1,000 tons of ore. The ore generally contains 30 to 45 percent Cr_2O_3 and the ratio of Cr to Fe ranges from 2.0 to 2.5. Little of the ore can meet normal specifications. Tulare County has no known chromite reserves, but Fresno County may have reserves of several hundred tons of shipping ore and about 10,000 tons of concentrating ore.

This report consists mainly of descriptions of individual mines and prospects based on published and unpublished information gathered during the war years 1915-19 and 1941-43. Detailed descriptions of the few deposits occurring in the western part of Fresno County are given in another report. The regional geology and the geology of the chromite deposits and associated rocks are given. A table showing the production by individual mines, and complete alphabetical lists of chromite mines and prospects in each county are included.

INTRODUCTION

The chromite deposits of Tulare and Fresno Counties (see fig. 2, pls. 6, 7) have yielded approximately 25,850 long tons of chromite ores, including 1,089 long tons of concentrates. Fresno County ranks seventh among the chromite-producing counties of California by virtue of a production of approximately 21,315 long tons of ore, whereas the 4,535 long tons of ore produced by Tulare County relegates it to only fourteenth place.[1] The major part of Fresno County's production has come from deposits in the eastern part of the county. Several small deposits occur in the western part, but their geographical location places them in another geologic province.

LOCATION AND ACCESSIBILITY

Tulare County and the eastern half of Fresno County cover approximately 7,850 square miles, and extend from the crest of the Sierra Nevada westward into the San Joaquin Valley. The western part of the region, adjacent to the plain of the San Joaquin Valley, is characterized by low, rolling foothills, but eastward the region becomes more rugged and mountainous, rising to Mt. Whitney, which is the highest point in the United States. The drainage system is dominated by the San Joaquin, Kings, and Kaweah Rivers and their tributaries.

The chromite deposits described in this report are within the foothill province of the southern Sierra Nevada. The district is served by a network of state and county roads. Railheads for the deposits in Fresno County are the spurs of the Southern Pacific Railroad at Clovis and the Atchison, Topeka, and Santa Fe Railroad at Piedra, whereas the deposits in Tulare County are readily accessible to stations along the main lines of either railroad as well as to the Visalia Electric Railroad. Although the climate is mild enough to permit mining the year round, trucking over some of the poorer access roads may be impaired during rainy periods. All the area in which the chromite deposits occur is covered by topographic maps, but only small parts of it have been mapped geologically.

SCOPE OF REPORT AND ACKNOWLEDGMENTS

Although high prices were offered for chromite during World War II, active mining of chromite in Fresno County was limited to only a few of the known deposits, and no chromite was mined in Tulare County. A preliminary examination of the area in 1942, made by the writer at the request of the Metals Reserve Company, indicated that many of the deposits had been worked out previously and that the reserves of most of the others were too low in grade to be mined as shipping ore and too small to warrant the erection of concentrating mills. Consequently, the U. S. Geological Survey made no attempt to examine systematically all the deposits, but examinations of the active properties and a few of the more promising inactive properties were made by G. A. Rynearson, F. G. Wells, and F. W. Cater Jr., during 1941, 1942, and 1943, as part of a nation-wide investigation of deposits of strategic minerals. Two of the producing mines also were examined and reported on by the U. S. Bureau of Mines in 1943 (Elliott 43). The results of these recent examinations and the published and unpublished data gathered by R. H. Toll for the U. S.

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[1] From compilations of federal figures for the periods 1880-99 and 1920-45 and state figures for the period 1900-19.

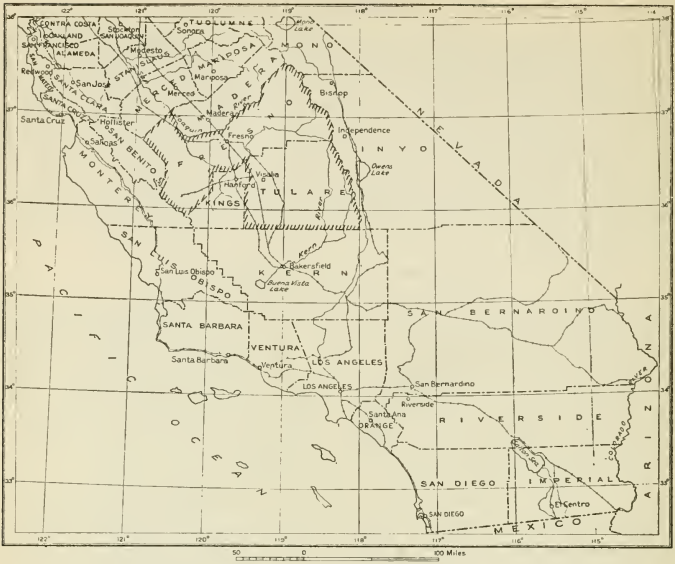

FIGURE 1. Index map of southern California showing the location of Fresno and Tulare Counties.

Bureau of Mines, N. L. Taliaferro for the California State Council on Defense, and engineers of the State Division of Mines between 1916 and 1918, have been utilized in the preparation of this report. Although much of the information used is incomplete and obviously out of date, an attempt has been made here to compile all the important available information in one report for a public record.

In describing the deposits the source of information is indicated at the end of each description by the name of the person reporting, followed by the last two figures of the year in which the mine was examined. All published and some unpublished reports to which reference is made are listed under *References* at the end of this report.

The aid and cooperation given to the Survey men by Mr. R. A. Fredericks, Mr. C. E. Hull, and others during the field examinations are gratefully acknowledged. The writer also is indebted to his colleagues in the Survey for their assistance in the preparation of this report.

HISTORY AND PRODUCTION

Chromite was discovered in Fresno County about 1853 by two Mexican prospectors who, believing they had found some silver ore, opened up a small ore body in what is now the New Idria quicksilver district. Their mistake was soon discovered, but the interest focussed on the area led to the discovery of quicksilver and the chromite deposits were more or less forgotten.

The first production of chromite ore in Fresno County probably took place in the early eighties from deposits in the eastern part of the county,

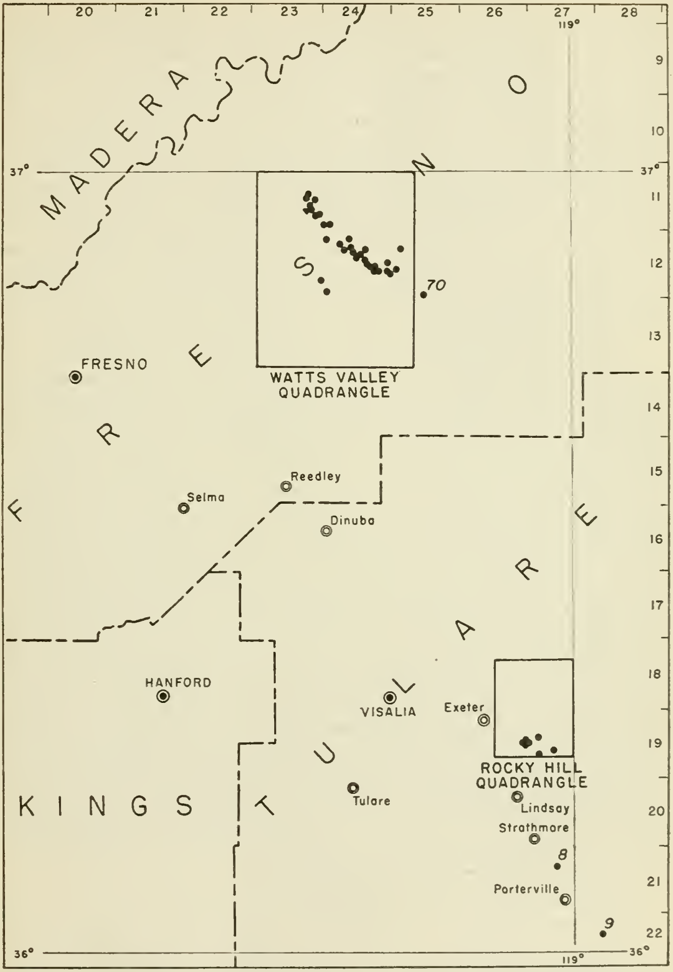

FIGURE 2. Map of Fresno and Tulare Counties, California, showing location of chromite deposits and outlines of the Watts Valley and Rocky Hill quadrangles.

where the ore was used for furnace linings in local copper smelters. There are, however, no records of the amounts of ore produced in this early period. One carload of ore was mined in Tulare County in the middle nineties. Production of chromite ore reached a peak in both Fresno and Tulare Counties during the war years of 1915-19, and nearly all the deposits now known were found during the intensive prospecting of that period. Except for a little desultory mining, the deposits remained idle until 1940, when active interest was renewed by the events foreshadowing World War II. A mill was constructed near the northern group of deposits in Fresno County and a small production of both lump ore and concentrates was continued from 1941-45. Most of the World War II production came from old mines reopened in the northern part of the district. Plans to erect a mill near Piedra to beneficiate ores from deposits in the southern part of the district were never carried beyond the paper stage. Tulare County had no production during World War II, as the deposits apparently had been worked out during earlier operations.

No definite figures of the production from Fresno and Tulare County chromite deposits prior to 1915 are available, but it is possible that the deposits may have yielded as much as 1,000 long tons of ore during the earliest operations. Detailed production figures for 1915-45 are given in tables 1 and 2. The figures in the main body of the tables have been taken from records used in compiling the totals listed in the Minerals Yearbook. Only those figurse given for 1941-45, when the Metals Reserve Company purchased all the ore, can be considered accurate and complete despite efforts made to eliminate recognizable errors and duplications in the earlier figures. Some of the records submitted by operators and purchasers prior to 1941 included the production from several undesignated mines, and in some cases the records duplicated each other. Some production was never reported, notably that prior to 1915. Thus, some of the figures may be too high and some too low, and the totals can only be regarded as approximate. To illustrate the discrepancies between production records, the yearly totals reported by the California Division of Mines for 1915-18 are shown at the bottoms of the tables. Because the totals shown are not in close agreement, an additional column has been included in the tables giving the estimates of production by Taliaferro (in Louderback 18), Toll (18), and others. These estimates, though not official, probably are more representative of the actual production. Furthermore, the sum of the World War I production reported by the California Division of Mines and the estimated pre-1915 production (1,000 tons) is in close agreement with the unofficially estimated pre-1919 total.

GEOLOGY

General Features

The geology of the area including and adjacent to the chromite deposits of Tulare and eastern Fresno Counties has been mapped only in part by Durrell (40), MacDonald (41), and Krauskopf (42) (see pls. 6, 7). Much work remains to be done before the complex geologic features are understood fully. In general, the rocks may be divided into three groups. The oldest rocks in the area are metamorphosed Mesozoic (?) sediments and volcanics, called the Kaweah series in one area (Durrell, 40). Intrusive bodies of serpentine and olivine gabbro are closely associated with them. All these older rocks were folded and then were intruded by a series of plutonic rocks which constitute the second group. The third and youngest group consists of Cretaceous and Tertiary sedimentary and volcanic rocks which were deposited over a part of the region after the pre-Cretaceous rocks had undergone a long period of erosion.

The metamorphic rocks are a heterogeneous assemblage of amphibolitic, micaceous, calcareous, and quartzose rocks derived from submarine volcanic flows and marine sediments. The volcanic rocks include flows and tuffs of basic, intermediate, and acidic compositions, though the basic and intermediate types predominate. Units of sedimentary origin include argillaceous, calcareous, and graphitic sediments as well as limestone and chert. Individual units of these rocks are lenticular and exhibit varying degrees of schistosity.

MacDonald (41) subdivided the metamorphic rocks in a part of Fresno County into three stratigraphic groups. The oldest group is composed chiefly of mica schists. Above this group is a younger group in which metamorphosed intermediate to basic volcanic rocks predominate. The youngest group is also characterized by mica schists.

Durrell (40) subdivided the Kaweah series in Tulare County into four stratigraphic units which he called the Yokohl amphibolite, the Lemon Cove schist, the Homer quartzite, and the Three Rivers schist. The Yokohl amphibolite is the oldest, and is composed principally of rocks derived from basic volcanic flows and tuffs. The Lemon Cove schist consists largely of rocks derived from acid to intermediate volcanic flows and tuffs. The Homer quartzite is characterized by siliceous rocks derived from cherts and graphitic phyllites. The youngest of the four stratigraphic units is the Three Rivers schist, which is similar to the Lemon Cove schist, but richer in argillaceous sediments and limestones.

Efforts to correlate the metamorphic rocks in the mapped areas with each other and with similar rocks elsewhere in the Sierra Nevada have met with little success because of the lenticular character of the lithologic units, the apparent lack of fossils, and the discontinuity of areas underlain by these rocks. Therefore, their age has not been determined satisfactorily. Durrell has tentatively correlated the Kaweah series with similar rocks of Upper Triassic (?) age found in the eastern part of Tulare County, but the possibility yet remains that the rocks may be equivalent to the Amador group of Middle and Upper Jurassic age described by Taliaffero (43) in Mariposa and Tuolumne Counties farther north; or they may represent parts of the Calaveras formation, which includes all pre-Mesozoic rocks in the Sierra Nevada.

The metamorphic rocks were intruded by sill-like masses of peridotite and olivine gabbro prior to being folded into a series of northwest-trending folds during the Nevadan revolution. The structures thus imposed on the rocks have not been worked out completely, but apparently no important overturning has occurred.

At the close of Jurassic time, after the older rocks had been folded, they were invaded by masses of plutonic rocks, ranging in composition and general sequence from hornblende gabbro and diorite to granite, accompanied by lamprophyric and pegmatitic dikes. This invasion by plutonic rocks resulted in the dynamothermal and contact metamorphism of the pre-existing rocks.

The long period of erosion following the Nevadan orogeny is marked by a profound unconformity between the pre-Cretaceous and the Upper Cretaceous and younger rocks.

Table 1. Chromite production from Fresno County, California, 1915-45

Property	Map no.	1915	1916	1917	1918	Pre-1919 unofficial estimate*	1919-40		1941	1942	1943	1944	1945	Total
							Year	Tons						
Alice	1	------	------	------	------	45	------	------	------	------	------	------	------	------
B. B.	13	------	------	------	------	300	------	------	------	------	------	------	------	------
Black Bow (Avery)	10	------	------	------	------	[18]	------	------	------	------	------	------	------	------
Blue Brush	12	------	------	21	6	29	------	------	------	------	------	------	------	27
Blue Diamond	[1]	------	------	------	------	------	1931	1	------	------	------	------	------	1
Brown Bird	8	------	------	------	------	11	------	------	------	------	------	------	------	------
Camden	17	------	------	[4]	------	85	------	------	------	------	------	------	------	------
Chrome Gulch Group	51–54													
Black Chief	------	------	------	------	------	150	------	------	------	------	------	------	------	------
Carson Property	------	------	[2]	[2]	------	150	------	------	------	------	------	------	------	------
Clara H	21	215	3,571	1,517	------	8,000	1940	15	728	496	11	81	16	6,650
Cripe Property	67	------	------	------	------	[13]	------	------	------	------	------	------	------	------
Despot-Moreau Lease	29	------	------	------	------	25	------	------	------	------	------	------	------	------
Dolly Varden	7	------	------	------	------	6	------	------	------	------	------	------	------	------
Doyle Lease	28	------	------	------	------	50	------	------	------	------	------	------	------	------
Ely and Gibons No. 1	------	------	------	------	------	[6]	------	------	------	------	------	------	------	------
Ely and Gibons No. 2	------	------	------	------	------	[30]	------	------	------	------	------	------	------	------
Erickson	27	------	------	------	------	?	------	------	------	------	------	------	------	------
Gardner	------	------	------	------	------	------	------	------	------	------	------	148	------	148
Houghton Property	70	------	------	18	------	18	------	------	------	------	------	------	------	18
Jack Sprat Group	39–44													
Jack Sprat No. 1	39	------	739	862	216	850	------	------	------	------	------	------	------	1,817
Black Joe	42	------	179	------	121	50+	------	------	------	------	------	------	------	300
Lookout	43	------	[3]	------	------	?	------	------	------	------	------	------	------	------
Nose	41	------	[3]	------	------	100	------	------	------	------	------	------	------	------
Valley View	44	------	[3]	------	40	50	------	------	------	------	------	------	------	40
Jeanne	[1]	------	------	62	27	110	------	------	------	------	------	------	------	89
Jensen Group	35,36,50													
Henry Ford	50	------	------	------	------	200–500	------	------	------	------	------	------	------	------
Lacey	15	------	------	1,435	1,150	3,000	------	------	------	128	296	299	------	3,308
Letty	20	------	------	------	------	10	------	------	------	------	------	------	------	------
Little Oak	6	------	------	------	23	?	------	------	------	------	------	------	------	23
Little Rock	37	------	------	------	------	[20]	------	------	------	------	------	------	------	------

Long Ledge Group	61–64													
Black Bear	63	------	6	46	------	450	------	------	------	------	------	------	------	52
Grizzly Bear	61	------	116	------	------	250	------	------	------	------	------	------	------	116
Riverview	62	------	------	------	27	150	------	------	------	------	------	------	------	27
Lotty	20	------	------	------	------	9	------	------	------	------	------	------	------	------
Lucky Boy	5	------	------	------	------	90	------	------	------	------	------	------	------	------
Manchester [4]	18	------	------	------	------	25	------	------	------	------	------	------	------	------
McMurtry	30	------	------	------	247	250	1935	67	------	------	------	------	------	314
Mountain Quail	2	------	------	------	------	70	------	------	------	------	------	------	------	------
Perry Property	11	------	------	[2]	[2]	150	------	------	------	------	------	------	------	------
Powers	------	------	------	------	74	150	------	------	------	------	------	------	------	74
Red Slide Group	55, 56													
Woodrow Wilson	56	------	------	------	154	250	------	------	------	------	------	------	------	154
Rock Wren	3	------	------	[2]	------	500–2,000	------	------	------	------	------	------	------	------
Rose Claims	38	------	------	------	------	40+	------	------	------	------	------	------	------	------
Saddle Blanket Group	45–49													
Black Hawk	------	------	[2]	[2]	------	400	------	------	------	------	------	------	------	------
Surprise	------	------	[2]	------	------	50	------	------	------	------	------	------	------	------
Tippecanoe	------	------	------	[2]	------	250	------	------	------	------	------	------	------	------
Wedge	------	------	[2]	------	------	250	------	------	------	------	------	------	------	------
Saint	22	------	------	------	127	150	------	------	------	------	------	------	------	127
Snyder Property	69	------	------	------	10	20	------	------	------	------	------	------	------	10
Sunset	16	------	------	------	------	100+	------	------	------	------	------	------	------	------
Terrill Property	65	------	------	------	------	10	------	------	------	------	------	------	------	------
Thelma Group	58–60	------	[2]	------	------	150	------	------	------	------	------	------	------	------
Virginia	14	------	------	------	------	?	------	------	------	------	------	------	------	------
Winchester	4	------	------	------	------	[2]	------	------	------	------	------	------	------	------
Unknown sources	------	68	549	268	424	------	1940	40	24	------	------	------	------	1,373
Totals	------	283	5,160	4,211	2,664	17,003-18,803	------	123	752	624	307	528	16	14,668
California Div. Mines Totals	------	1,300	9,060	6,289	2,314									

---

[1] In western part of county.
[2] Included in production from Jack Sprat No. 1.
[3] Included in production from Black Joe.
[4] Included in production from Clara H.
* Totaled separately. Bracketed figures represent ore stocks, not added because some is below shipping grade.

Table 2. Chromite production from Tulare County, California, 1915-18

Property	Map no.	1915	1916	1917	1918	Total	Pre-1919 unofficial estimate*
Bowlin	2	------	------	------	------	------	100
Earl Smith	6	------	------	------	------	------	255
Gill (Gill Ranch)	1	------	------	------	250	------	400
Gill	7	------	------	------	------	------	?
Holston (Vaughn)	9	------	1,605	------	312	------	3,325
James	8	------	------	------	------	------	175
Sattlefield	4	------	------	------	------	------	75
Waddell	3, 5	------	------	------	------	------	110
Totals	------	------	1,605	------	562	2,167	4,440
California Div. Mines Totals	------	[1]	3,435	450	600	4,485	------

[1] One mine shipped ore. Name and amount not known.
* Totaled separately.

The exposed younger rocks include sandy marine sediments of the Chico formation of Upper Cretaceous age, non-marine sandstones, conglomerates, and rhyolitic gravels of the Ione formation of Eocene age, and basalt flows of Miocene (?) age. These rocks apparently were deposited only in the western part of the region and are exposed only in the northwestern part. Presumably they are covered by Recent gravels and alluvium in the southwestern part. Uplift of the Sierra Nevada during late Pliocene or post-Pliocene time has tilted the Tertiary rocks gently westward.

Ultramafic Rocks

Although chromite occurs in many rocks as a minor accessory mineral, it is an important accessory only in ultramafic rocks or in serpentine derived from them. In California appreciable concentrations of chromite always are associated with the variety of ultramafic rock called dunite. This latter fact is of great importance in studying the deposits and may be of considerable aid in searching for new deposits or in exploiting known deposits. Prior to the present investigations, but little attention was given to differentiating varieties of ultramafic rocks in the field. However, the salient distinguishing characteristics of ultramafic rocks are given below, along with the alteration, distribution, and structures of those types found in Fresno and Tulare Counties.

Lithology. The ultramafic rocks as a whole are commonly called serpentine by the prospector and geologist alike because they are more or less altered to minerals of the serpentine group. The ultramafic rocks found in Tulare County and the eastern part of Fresno County have been almost completely altered to serpentine. Furthermore, additional alterations have formed other minerals that further mask the original character of the rocks. Nevertheless, often it is possible to distinguish the original variety of rocks, and in this report the varietal name is used when the original rock has been recognized. The term peridotite is used to denote undifferentiated rocks of the group whose general physical appearance still resembles that of the original rocks. Otherwise the rocks are referred to as serpentine.

Peridotite is an ultramafic rock consisting chiefly of olivine and pyroxene. The olivine-rich variety of ultramafic rock, containing more than 95 percent olivine and little or no pyroxene, is called dunite; whereas the pyroxene-rich variety, containing more than 95 percent pyroxene, is called pyroxenite. The varieties containing 5 to 95 percent pyroxene, in addition to the olivine, are called saxonite, wehrlite, or lherzolite, depending on whether the pyroxene is enstatite, diallage, or both. Saxonite is the most abundant type represented in the region. Dunite is also common, but pyroxenite has been noted in only one locality. Neither wehrlite nor lherzolite has been recognized in the region. These rocks are distinguished from one another in the field by the following criteria. Olivine generally alters to antigorite, which has a rather uniform texture and weathers readily to a smooth surface. On the other hand, enstatite usually alters to bastite, which retains the pyroxene cleavage and resists weathering to a greater degree than antigorite. Thus, weathered surfaces of moderately altered saxonite are studded with bastite pseudomorphs in relief. Saxonite and dunite both are dark grayish-green to almost black on freshly broken surfaces, but the silver- or bronze-colored remnants of the altered enstatite crystals are usually a little lighter than the altered olivine. Both rocks weather to reddish-brown, but weathered dunite tends to have a lighter buff color. The great preponderance of weather-resistant pyroxene or bastite in pyroxenite gives it a characteristically rough surface which distinguishes it from the smooth-surfaced dunite and the studded saxonite.

Alteration. Much of the peridotite in the area has been serpentinized so intensely, and otherwise altered or sheared, that all the original characteristics have been obliterated. Such rock can be referred to only as serpentine. Serpentine rock has a dark greenish-gray to nearly black color and weathers to lighter shades of gray and green. Serpentine is an incompetent rock and fractures easily into irregular blocks having smooth, waxy, slickensided surfaces. Highly sheared serpentine is called ''slickentite.''

Most of the serpentinization took place at an early stage, probably not long after the masses of peridotite were intruded. Much talc and magnesite also have been developed in the rocks, especially along or near dikes of other igneous rocks and in thoroughly shattered areas. In a few places, as at Piedra (see pl. 6), commercial deposits of magnesite have been formed in the serpentine. Tremolite, actinolite, and clinochlore also are common throughout the serpentine, and locally the rocks have been completely altered to a talc-tremolite rock. Olivine and a little enstatite occurring in some of the highly altered rocks near contacts with granitic intrusives have been interpreted by Durrell (40) and MacDonald (41) as regenerated forms of these minerals.

Distribution and Structure. The peridotite and serpentine bodies found in the area are restricted to a narrow belt extending northwest across the counties, roughly parallel to the regional trend (see pls. 6 and 7). All the peridotite and serpentine have not been mapped as yet, and some of the smaller masses have not been delineated in the areas that have been mapped. A part of the belt is covered by alluvium.

The peridotite was intruded into the stratified Mesozoic (?) sedimentary and volcanic rocks as masses whose forms are essentially sill-like, though discordant relationships are common. In general, these masses were intruded into the volcanic rocks rather than into the sedimentary rocks. In Fresno County they occur in the meta-volcanic rocks near the middle of the stratigraphic section; in Tulare County they are found in the meta-volcanic rocks in the lower part of the section. Small roof pendants of serpentine are found isolated in the granitic rocks in a few places. The largest mass of peridotite in the region is the Hog Mountain-Red Mountain sill in the Watts Valley quadrangle (see pl. 6). Although not completely mapped, this mass is known to be more than 12 miles long and to range from about 6,000 feet to perhaps 20,000 feet in thickness. Other masses are much smaller, however, and some are only a few hundred yards long and a few hundred feet thick. The size of a peridotite mass apparently has little bearing on the size of chromite deposits the mass may contain. The largest mass contained the largest ore body yet found in the area, but a much smaller mass contained an ore body nearly as large. A large peridotite mass is likely to contain more ore bodies than a smaller mass and the chances of finding large ore bodies in large masses therefore are greater.

The peridotite bodies have undergone the same regional deformations as the enclosing metamorphic rocks. A good example of the results of the deformations is the Hog Mountain-Red Mountain sill mentioned above, whose outcrop represents the trough and both limbs of a plunging syncline. The borders of the peridotite and serpentine masses generally are sheared into "slickentite." Shearing and minor faulting also occur within the masses. The internal shear zones are roughly parallel to the contacts in small narrow masses, but may have almost any direction when well within the largest masses. Shearing also has taken place along nearly all the zones in which massive ore bodies occur. The rudely developed schistosity exhibited by some of the peridotite probably represents a primary structure that originated as the masses were intruded and was accentuated by the regional deformations.

Characteristics of Chromium Ores

Composition of Chromite. The only ore mineral of chromium is chromite, an iron-black to brownish-black mineral with a submetallic luster and a brown streak. Finely sheared or crushed chromite has a chocolate-brown color and a dull luster. Chromite is an isometric mineral of the spinel group. Stevens (44) has shown that chromite is an isomorphic compound of the end members magnesiochromite ($MgO.Cr_2O_3$), ferrochromite ($FeO.Cr_2O_3$), spinel ($MgO.Al_2O_3$), hercynite ($FeO.Al_2O_3$), magnesioferrite ($MgO.Fe_2O_3$), and magnetite ($FeO.Fe_2O_3$). Chromite may therefore have a wide range in composition depending upon the combination and proportions of the above end members. Thus, chromites from different deposits have different compositions, and even the chromite within an individual deposit may vary in composition, although the range probably is rather limited in the latter case.

Other Chromium Minerals. Small amounts of several economically insignificant chromium-bearing minerals occasionally are found associated with chromite deposits. These minerals are of scientific interest as they may aid in determining the genetic relationships of the deposits. The most common of these minerals are the emerald-green chromium-bearing garnet uvarovite, the purple to pink chromium-bearing chlorite kammererite, and the bright green chromium-bearing pyroxene chrome-diopside. Taliaferro (18) reported the presence of kammererite in some of the deposits of Fresno County and uvarovite has been noted in at least one of the deposits. Although chrome-diopside has not been reported as yet, it may be found with further searching.

Uses and Specifications. Chromite is used in the manufacture of metallurgical, refractory, and chemical products. The specifications for chromite ores vary with the use and also with the supply and demand. Ores to be used for metallurgical purposes are usually required to have at least 45 percent Cr_2O_3 and a Cr :Fe ratio of at least 3. Ores containing a relatively low percentage of Cr_2O_3 may be used for refractory purposes providing the combined content of Cr_2O_3 and Al_2O_3 is at least 60 percent. High-iron ores are preferred for chemical purposes as they are more readily decomposed, but it also is desirable that the Cr_2O_3 content be high so that the conversion to chromium salts can be done with a minimum amount of material. Silica is undesirable; more than 10 percent SiO_2 renders an ore unsuitable for metallurgical purposes, and not more than 5 to 8 percent SiO_2 is desired for chemical purposes. All ores contain some silicate gangue minerals, and when present in excess, as in disseminated ores, they must be eliminated by some milling process to make the ores acceptable. Sulfur in excess of 0.50 percent and phosphorous in excess of 0.20 percent are also undesirable, but these are not usually present in deleterious amounts.

The specifications outlined above are those for a normal market and current industrial practices. Practically none of the ore found in Fresno and Tulare Counties can meet these specifications regardless of price. Only a revision of the specifications due to advanced metallurgical procedures and an interruption of supplies of cheaper and better foreign ores can make the deposits economically significant.

Nature of Ore Bodies

Two distinct types of chromite ore bodies are found in Fresno and Tulare Counties, as elsewhere in California. Ore consisting of chromite grains more or less dispersed in the host rock is called disseminated ore, whereas that consisting of a dense aggregate of chromite grains is called massive ore. A less distinct type consists of chromite grains accumulated into small clusters or ellipsoidal nodules. This latter type may be considered as one or the other of the main types, depending upon the relative concentration or spacing of the nodules.

Disseminated Type. Disseminated ore consists of chromite grains scattered at random or accumulated into small clots, clusters, stringers, or crude layers in dunite. Ore bodies of this type, as well as the accumulations of chromite within such ore bodies, grade outward into leaner or barren dunite. Disseminated ore may contain from 10 to 75 percent, and locally as much as 90 percent chromite, grading into massive ore on the one hand and rock containing only accessory chromite on the other. Although disseminated ore bodies generally have a lenticular or tabular form, they may be highly irregular also. Linear elements exhibited by the chromite commonly indicate the longer axis of an ore body, and both linear and planar elements are parallel to corresponding structures within the enclosing dunite and peridotite. Disseminated ore may occur anywhere within a large or small dunite mass, but many dunite masses do not contain any ore bodies. Some ore bodies contain only a few hundred pounds of ore, while others have been known to contain more than 100,000 tons of ore. Fresno County has no known disseminated ore deposits that contain more than a few thousand tons of ore, and most of the deposits contain only a few tens or hundreds of tons.

Massive Type. Massive ore is distinguished from disseminated ore mainly in that it consists largely of chromite with little or no interstitial gangue. Massive ore generally has rather sharp contacts with the barren dunite or serpentine, but in many places there is a thin transitional zone or an envelope of disseminated ore around the massive ore. The forms of massive ore bodies are highly variable, ranging from tabular masses to irregular masses called stringers, lenses, kidneys, pods, and knockers by the miners. Like disseminated ore bodies, the massive ore bodies may occur anywhere in the dunite, and in many places there may be only a very thin shell of dunite surrounding the ore. Not uncommonly, a series of ore bodies is strung out along a narrow zone in the dunite. Such a zone is essentially a zone of weakness and of shearing, hence the fact that many ore bodies occur along shear zones. Not all shear zones contain ore bodies, however. Shearing accounts in part for some of the irregularities of the ore bodies and tends to orient them with their long axes parallel to the direction of shear. When an ore body has been found in a shear zone the search for additional ore should be confined to the limits of the shear zone and in the directions indicated by the long axis of the ore body. The size of massive ore bodies ranges from a few hundred pounds to more than 10,000 long tons. Although a few of the deposits in Fresno County have yielded several thousand tons of ore from a group of ore bodies, it is doubtful whether any individual ore body contained more than 500 long tons. Most of them contain less than 100 tons.

RESERVES

The known reserve of chromite ores in Fresno and Tulare Counties is small. No reserves of either massive or disseminated ore can be estimated for Tulare County until new deposits are found or the old deposits are explored further. Most of the known deposits in Fresno County are considered to be worked out. A few widely scattered deposits in the Hog Mountain-Red Mountain area should yield several hundred tons of shipping ore, but only three mines show good indications of having more than a few tons of such ore in reserve. These three may hold as much as 2,500 long tons of ore containing 30 to 35 percent Cr_2O_3, part of which could be sorted to a product containing about 40 percent Cr_2O_3. One of these deposits may hold about 7,500 long tons of disseminated ore containing 5 to 10 percent Cr_2O_3. Inasmuch as all three mines are on the south slope of Hog Mountain, a small mill would serve to concentrate the reserves of both massive and disseminated ore in the deposits. It should be possible to obtain about 2,500 long tons of concentrate containing 40 to 45 percent Cr_2O_3 by milling the ores of these deposits. The Cr:Fe ratio of any concentrates thus produced probably would be somewhat less than 2.5.

Other ore bodies undoubtedly are present in the ultramafic rocks of both counties, some at or near the surface and others at depth, but even those near the surface may be very difficult to find. Several large deposits of chromite have been found in the counties and others may exist. This possibility may furnish the incentive for future prospecting. Additional exploration of the largest of the old mines, as was done successfully at the Lacy and Clara H mines during World War II, offers the best possibility of developing larger reserves, but small deposits or outcrops of chromite should not be overlooked as they may indicate the presence of an ore zone containing sizable ore bodies at greater depth.

DESCRIPTION OF DEPOSITS

In the following pages, each deposit is described under the most recent name known except in a few cases in which the old and new names of a group of properties cannot be correlated definitely. In such cases the old names are given priority. However, reference is made to other names by which the properties were known. The deposits are numbered and arranged geographically by counties. Deposits which are identified by number on the Economic Mineral Map of California[2] are indicated by the corresponding number in brackets.

Fresno County

More than 70 chromite mines and prospects in the eastern part of Fresno County have been examined by state and federal engineers or geologists. Many other minor occurrences of chromite have been reported, but no details are available regarding them. One local miner estimated that nearly 200 separate deposits have been found in the area. The ownership of, and mining rights to most of the properties have changed hands several times and some of the deposits mentioned in scattered reports under other names may be identical with some deposits described in this report.

All but three of the deposits described below occur in the large synclinal mass of ultramafic rocks exposed in the Watts Valley quadrangle (see pl. 6), and all but three of these occur in the exposed parts of the trough and northeastern limb of the syncline. Inasmuch as outcrops are good and the area has been thoroughly prospected, the surface distribution of deposits as shown on plate 6 is probably representative of the distribution throughout the mass. The apparent scarcity of ore bodies in the western limb of the syncline suggests that the early differentiation processes of the mass tended to segregate most of the chromite and dunite bodies into those parts of the mass now represented by the exposed parts of the trough and northeastern limb of the syncline. However, additional detailed mapping is needed to substantiate this hypothesis.

Alice Mine (1)

The Alice mine, also known as the Partridge claim, is at an altitude of 2200 feet on a spur in the SW¼SW¼ sec. 13, T. 11 S., R. 23 E. The mine was operated by S. W. Hazelton in 1918. The workings consist of three short adits and two small pits. The ore was bought by H. S. Doyle and trucked directly from the mine to the railroad.

According to Taliaferro, ore was exposed only in one tunnel and one pit. It occurred as small irregular bodies in soft sheared serpentine which was cut by soft decomposed aplitic dikes. Scattered grains of chromite occur in the harder serpentine nearby, and a few small stringers of chromite crop out near the upper adits. The deposit has yielded 40 to 50 long tons of ore containing about 40 percent Cr_2O_3. (Taliaferro, in Louderback 18)

Mountain Quail Mine (2)

The Mountain Quail mine is south of the Alice mine on a steep hillside in the NW¼NW¼ sec. 24, T. 11 S., R. 23 E. The Lavensaler-Speir Corporation of San Francisco owned the property in 1918. A sled road connected the mine with the truck road to the Alice mine. The workings consist of an adit trending N. 30° E. for 60 feet then S. 30° E. for 15 feet, and 20 feet of raise from the bend in the adit to an open cut at the surface.

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[2] Outline geologic map of California, showing locations of chromite properties; Economic Mineral Map of California, No. 3—Chromite, California Div. Mines, 1942.

Taliaferro reported that the ore occurred as irregular pod-shaped masses in slickensided serpentine. He saw 4 or 5 tons of unmined ore in the workings. The mine was idle at that time. About 70 long tons of ore was shipped in 1917. (Taliaferro, in Louderback 18)

Rock Wren Mine (3) [76]

The Rock Wren or Serpentine mine is at an altitude of about 2200 feet in the NW¼NW¼ sec. 24, T. 11 S., R. 23 E. It was operated by the Union Chrome Company until 1917. The Fresno Chrome Company leased the property in 1918. The mine workings consist of a series of long, narrow open cuts, or stopes to the surface, connected by tunnels. These workings trend south-southeast for 50 feet then southeast for about 100 feet. They are 8 to 20 feet wide and at the southeast end they are about 60 feet deep. A sled road runs from the mine to the truck road to the Alice mine.

Apparently the ore occurred as a more or less continuous series of small lenses of chromite aligned parallel to the schistosity of the serpentine. Taliaferro saw several small lenses 6 to 12 inches wide and 2 to 10 feet long which he estimated to contain at least 10 tons of ore. He also noted that at least 250 long tons of material on the dump contained perhaps 15 percent Cr_2O_3 in "fines" which could be concentrated easily. Although parts of the workings were caved or filled so that portions of the ore zone were obscured, Taliaferro thought the prospects of developing more ore were good. Local estimates variously place the past production at 500 to 2,000 long tons. (Taliaferro, in Louderback 18; Bradley 18, p. 145)

Lucky Boy Mine (5)

The Lucky Boy mine is in the SW¼NW¼ sec. 24, T. 11 S., R. 23 E. southeast and several hundred feet higher than the Rock Wren mine. H. W. Hollingsworth owned the mine during World War I. The workings consist of two pits 8 and 25 feet deep and 15 feet apart.

Part of the ore consists of ellipsoidal nodules of chromite separated by serpentine. Some of the nodules are as much at 1½ inches in diameter, but their average diameter is a little less than half an inch. The nodular ore grades into ore consisting of irregular grains and clusters of grains of chromite in a matrix of serpentine. Taliaferro believed the ore in the pits represented two separate ore bodies. He estimated the ore in the larger pit, of which there was about 10 long tons exposed, contained about 35 percent Cr_2O_3, whereas the ore in the smaller pit contained only 28 to 29 percent Cr_2O_3. About 90 long tons of ore containing 33 to 35 percent Cr_2O_3 has been mined and shipped from the property. (Taliaferro, in Louderback 18)

Little Oak Mine (6)

The Little Oak or Lava mine is in the NE¼NE¼ sec. 23, T. 11 S., R. 23 E. There are two groups of workings on the property. The lower workings constitute the original Little Oak mine, which was worked first in 1905 by the Union Chrome Company. Taliaferro reported that this part of the property had been leased to the Fresno Chrome Company by the Lavensaler-Speir Corporation. The old workings were caved in 1918, and a tunnel was being driven to intersect them below an open cut 50 feet long, 15 to 20 feet wide, and 30 feet deep. Taliaferro did not see the ore said to be present in the bottom of the cut as it was covered with waste. About 10 long tons of float ore was gathered and shipped in June 1918.

Another deposit had been opened by a pit and two trenches about 500 feet west and 200 feet above the lower workings. The rights of the Fresno Chrome Company to this part of the property were being contested by Howard Strassbaugh, who held a lease from Oscar C. Collins in 1918. A lens of massive ore 6 inches wide and 4½ feet long had been exposed in the pit. This lens had a strike of N. 5° E. and a dip of 50° E., and was cut off on one end by a cross fault. About 5 tons of float ore had been dug out of the trenches. No ore had been shipped. (Taliaferro, in Louderback 18)

Brown Bird Mine (8)

The Brown Bird or Lookout mine is near the line between secs. 23 and 24, T. 11 S., R. 23 E., and is just below the Black Bow (Strassbaugh) claim (see fig. 2). The only mine-opening reported by Taliaferro was a short adit trending S. 50° E. parallel to the vertical schistosity of the serpentine. The ore occurred as rather small lenses in a narrow zone. None of the lenses exposed was more than 8 inches thick, and these contained only about one ton of ore. Seven long tons of ore had been shipped and 4 long tons was ready for shipment. (Taliaferro, in Louderback 18)

Black Bow Claim (Strassbaugh) (9)

Howard Strassbaugh owned a claim called the Black Bow which is in the NW¼NW¼ sec. 24, T. 11 S., R. 23 E. north and a little lower in elevation than the Lucky Boy mine (see fig. 2). A small cut 4 feet deep represented the only work done when Taliaferro visited the property in 1918. About 2 long tons of nodular ore and several small lenses of massive ore were exposed in the cut. He estimated the ore to contain 33 percent Cr_2O_3. (Taliaferro, in Louderback 18)

Black Bow Claim (Avery) (10)

Toll examined a Black Bow claim owned by O. G. Avery that apparently was not the same as the Black Bow claim owned by Howard Strassbaugh. Avery's claim is a quarter of a mile south of the Brown Bird claim in the SE¼NE¼ (?) sec. 23, T. 11 S., R. 23 E. The property was exploited by an underhand stope 20 feet long and 20 feet deep. A lens of ore 14 inches wide was exposed to a depth of 44 inches in the eastern end of the cut. A sample taken from 18 tons of ore piled on the dump assayed 29.2 percent Cr_2O_3. (Toll 18)

Perry Property (11) [73]

The Perry property, also known as the Perry placer or Fairview deposit, is in the NE¼ sec. 24, T. 11 S., R. 23 E. near the serpentine and schist contact about a mile north of the Lacey mine (15). The property is owned by Bernice Perry and was operated by Frank Carson and F. M. Perry in 1918. No ore was found in place, but about 150 long tons of float ore was recovered, some of it by plowing the soil and picking out the lumps of ore which were turned up. (Taliaferro, in Louderback 18; Toll 18)

Blue Brush Mine (12)

The Blue Brush mine, also known as the Wolfe mine, is three-quarters of a mile N. 13° W. of the Lacey mine (15) in the NW¼SW¼ sec. 24, T. 11 S., R. 23 E. Elmer Wolfe mined the deposit by an open cut 30 feet long and 5 to 10 feet wide. He shipped 21 long tons of ore containing 41 to 42 percent Cr_2O_3 in 1917. No unmined ore was exposed in 1918, but 8 long tons of ore was stacked on the dump. (Taliaferro, in Louderback 18; Toll 18)

B. B. Mine (13) [76]

The B. B. mine is half a mile north of the Lacey mine in the SW¼ sec. 24, T. 11 S., R. 23 E. Bertha Linderman, et al. were the owners in 1918. It is reported that six carloads of ore was mined and shipped in 1917. (Taliaferro, in Louderback 18)

Virginia Mine (14)

The location given for the Virginia mine is not definite. Toll reported the location to be a quarter of a mile from the Lacey mine (15), so the Virginia workings may be identical with those in the SE cor. SW¼ sec. 24, T. 11 S., R. 23 E. According to Toll, the mine was leased by the Fresno Chrome Company from the Lavensaler-Speir Corporation in 1918. The workings consisted of an open cut 50 feet long and a shaft 10 feet deep 20 feet from the face of the cut. It appeared to Toll that the ore occurred as small lenses in shattered serpentine which was much altered to talc and magnesite and cut by granite dikes. Most of the ore probably had been mined prior to his visit. The total amount of ore taken from the deposit is not known. (Toll 18)

Powers Mine

Bert Hammel and George Hahnemann located the H. H. and Moonshine claims on a property formerly known as the Powers mine. This property is probably in the eastern part of sec. 24, T. 11 S., R. 23 E. near the serpentine and schist contact. Toll reported two groups of workings. The upper workings consisted of an adit 200 feet long trending N. 45° E., a raise to the surface from a point 60 feet inside the adit, and an underhand stope 45 feet long and 45 feet deep below the raise. An adit was driven for 160 feet at a level about 100 feet lower than the upper adit in hope of finding ore beneath the stope. No ore was found, however, and Toll noted that the adit had been driven in mica schist. The mine is supposed to have yielded several carloads of ore. (Toll 18)

Ely and Gibons Deposits

Willis Ely and William Gibons worked two chromite deposits during World War I. The location of their "No. 1" mine is not given in Toll's report, but he described the workings as consisting of an open cut trending N. 30° E. for 20 feet and a winze 6 feet deep. He noted 6 long tons of ore stacked on the dump. The "No. 2" mine is east (?) of the Lacey mine (15), probably in the southeast corner of sec. 24, T. 11 S., R. 23 E. The western workings of this mine consisted of an open cut 20 feet long, a shaft 10 feet deep, and a drift trending S. 15° W. for 26 feet. The eastern workings, 600 feet to the east, consisted of an open cut 14 feet long and an adit 30 feet long 10 feet below the cut. Toll does not mention seeing any ore in place, but reported about 30 long tons of ore stacked on the various dumps. (Toll 18)

Lacey Mine (15) [76]

The Lacey mine is at an altitude of about 1,950 feet on 40 acres of patented lands in the NE¼NW¼ sec. 25, T. 11 S., R. 23 E. Operators during World War I included the Union Chrome Company, the Mineral

Resources Corporation of America, and L. R. Payne and C. S. Snow. The present owner is Mrs. Eloise Edwards, who leased the mine to R. A. Fredericks in 1941 and J. E. Babcock and partners in 1942.

The early workings consisted of a series of surface cuts, pits, and trenches which were more or less continuous for 300 to 400 feet along the outcrop, and several shafts, drifts, and crosscuts. One shaft was 70 feet deep and had no ore in the bottom. Below this level, a crosscut tunnel was driven 324 feet without finding ore. About 100 feet to the north was another shaft 30 feet deep and a tunnel 50 feet long in which a winze had been sunk to a depth of 35 feet. Another crosscut tunnel, at a level 30 feet lower than the winze, had been driven 120 feet in the direction of the winze when Toll visited the property in 1918.

In 1941 R. A. Fredericks drove a crosscut tunnel 170 feet S. 72° E. in an attempt to intersect the ore zone 75 feet below its outcrop (see fig. 3), but he encountered old workings and abandoned his lease. In 1942 J. E. Babcock and his partners started an incline 130 feet inside the Fredericks tunnel. Finding ore at a depth of about 25 feet, they drifted and stoped along the ore zone for about 100 feet. They planned to steepen the incline and extend it to a new level 50 feet lower during 1943.

The ore occurs in slickensided serpentine as a series of irregular and lenticular-shaped masses of chromite scattered along a shear zone which strikes about N. 10° W. and dips steeply east. Ore has been found along the zone for about 400 feet at the surface and has been mined to depths of 100 feet or more. Most of the individual ore bodies in the deposit are rather small, ranging from a few inches to 5 feet in thickness and are several times these amounts in length, but they are either closely arranged or are interconnected by thin stringers of chromite.

No analyses of the pure chromite are available, but it is probable that the mineral contains about 50 percent Cr_2O_3, as a 55-ton shipment of concentrates made from the ore contained 47.40 percent Cr_2O_3. The crude ore varies in grade from one lens to another, largely because of varying amounts of interstitial serpentine. Although some of the crude ore mined has contained as little as 30 percent Cr_2O_3 and has required concentration, the major part of the ore mined has contained 42 to 46 percent Cr_2O_3 and the ratio of Cr :Fe has ranged from 2.2 to 2.8. The composition of the crude ore, and of the chromite to some extent, is indicated by partial analyses of 160 tons of ore. These analyses showed an average of 43.5 percent Cr_2O_3, 11.7 percent Fe, 14.5 percent Al_2O_3, 17.0 percent MgO, and 4.5 percent SiO_2, and a Cr :Fe ratio of 2.54.

Production records for the mine are somewhat confused with records for other mines in the district. The mine is credited with a production of 1,435 long tons in 1917 and 1,150 long tons in 1918. The production for 1916 may be included in the figure for the Clara H mine for that year. The total production during World War I was probably close to 3,000 long tons, as is suggested by Taliaferro and Toll. This ore averaged about 42 percent Cr_2O_3. Production during World War II amounted to 128 long tons in 1942, 296 long tons in 1943, and 299 long tons in 1944. The total of 723 long tons of ore produced during World War II included 574 long tons of crude ore and 149 long tons of concentrates. This ore had an average Cr_2O_3 content of 44.6 percent and a Cr :Fe ratio of 2.54. The total known production of the mine is approximately 3,725 long tons.

Inasmuch as no adequate record of the true nature and extent of the underground workings has been kept, there is no reliable basis available

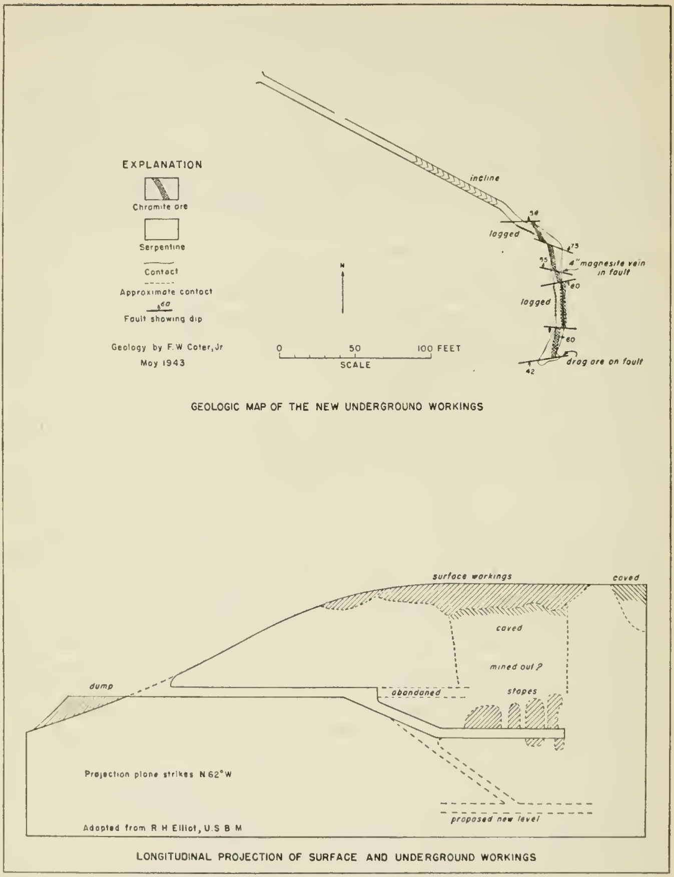

FIGURE 3. Geologic sketch map and longitudinal projection of part of the Lacey mine, Fresno County, California.

on which an estimate of reserves can be made. Some ore undoubtedly remains in the explored part of the ore zone, i.e., in the intervals between the old workings, but the location and amount of such ore only can be determined by additional exploration. Furthermore, the feasibility of mining much of this ore is doubtful. However, the large past production and the relatively good grade of the ore would justify additional exploration if the market conditions for chrome ores ever attain the wartime levels of the past. (Cater 43; Elliott 43; Rynearson 42; Wells 41; Toll 18; Taliaferro, in Louderback 18; Bradley 18, p. 144)

Sunset Mine (16)

The Sunset mine is in a small gulch in the SE¼NE¼ sec. 26, T. 11 S., R. 23 E. The mine was operated in 1918 by the Fresno Chrome Company, which owned half of the property and leased the other half from the Lavensaler-Speir Corporation. When Taliaferro and Toll visited the property it was developed by an adit trending N. 20° W. for 35 feet to a winze 90 feet deep.

According to Taliaferro, the ore occurred as a nearly vertical series of lenses having a trend about the same as that of the adit. Some of the ore was ''frozen'' to the serpentine wall rock. He saw a lens of ore 6 feet long and 1 to 2½ feet thick in the top of a stope 6 feet below the adit level. He was told that another lens of ore 2 feet thick was exposed in the bottom of the then inaccessible winze. Subsequent operations probably mined these and other ore bodies in the deposit. More than 100 long tons of ore containing 40 to 42 percent Cr_2O_3 was shipped from this mine. (Toll 18; Taliaferro, in Louderback 18)

Camden Mine (17) [76]

The Camden mine is near the crest of a ridge south of the Sunset mine (16) in the SE¼NE¼ sec. 26, T. 11 S., R. 23 E. The Fresno Chrome Company leased the property from the Lavensaler-Speir Corporation in 1918. About 85 long tons of ore containing 40 to 42 percent Cr_2O_3 was mined from a large pit, or underhand stope, 8 to 15 feet wide, 20 to 25 feet long, and 35 feet deep. Only a few small stringers of ore remain in the pit and apparently the deposit has been worked out. (Taliaferro, in Louderback 18; Bradley 18, p. 145)

Manchester Mine (18)

The Manchester mine is about 1,000 feet south-southeast of the Camden mine (17) in the SE¼NE¼ sec. 26, T. 11 S., R. 23 E. Ownership of the mine was claimed by Howard Strassbaugh and by the Fresno Chrome Company. The shaft and other underground workings had been blown up. It is reported that the mine yielded 25 long tons of ore containing 44 percent Cr_2O_3 and that a lens of ore 6 inches wide and 5 feet long remained in the bottom of the shaft.

Howard Strassbaugh and J. W. Hazelton dug a small cut and several trenches on a small chromite occurrence below the Manchester mine and called it the Manchester Extension. Only about 500 pounds of ore was found.

A small deposit on the Manchester claim northeast of the main workings was known as the Side Kicker mine. About one ton of ore was mined from a small cut and only a small amount of ore remained in place. (Taliaferro, in Louderback 18)

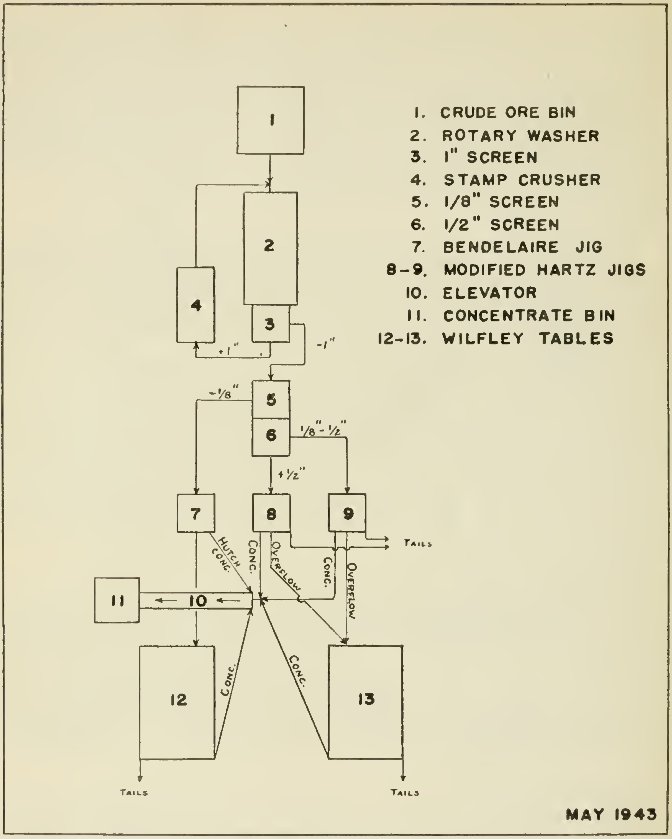

FIGURE 4. Flow-diagram of the Clara H chromite mill, Fresno County, California.

Victor Mine (19)

Howard Strassbaugh and J. W. Hazelton owned a prospect they called the Victor mine which is in the SE¼NE¼ sec. 26, T. 11 S., R. 23 E. east-southeast of the Letty claim (20). About one ton of ore was found as float or dug out of small lenses in the serpentine. (Taliaferro, in Louderback 18)

Letty and Lotty Claims (20)

The Letty and Lotty claims are in the SE¼NE¼ sec. 26, T. 11 S., R. 23 E. northeast of the Manchester mine (18). They were owned by H. S. Doyle and Howard Strassbaugh in 1918. The only development work consists of a small open cut on each claim. The ore occurred as small lenses in sheared serpentine. Shipments of about 10 long tons of ore from the Letty claim and 9 long tons from the Lotty claim have been reported. This ore contained 43 to 44 percent Cr_2O_3. The deposits have been mined out. (Taliaferro, in Louderback 18)

Clara H Mine (21) [76] and Mill (25)

The Clara H mine is at an altitude of 1900 feet near the center of the NW¼ sec. 25, T. 11 S., R. 23 E., on land patented and owned by Spear and Loffinger of San Francisco. R. A. Fredericks leased and operated the mine from 1941 to 1945. He also built and operated a concentration mill near the line between secs. 25 and 30 on a tributary of Watts Creek almost a mile southeast of the mine. According to Mr. Fredericks, the mine was first operated from 1880 to 1882. The Union Chrome Company reopened and operated the mine during the early years of World War I, and the Fresno Chrome Company held a lease on the property in 1918.

The extent of the earliest workings at the mine is not known. Toll reported in 1918 that the workings consisted of a shaft 100 feet deep, about 100 feet of drifts, a winze, and a large open cut 60 feet wide and more than 100 feet long. Recent operations were confined to surface workings.

The ore occurs in soft serpentinized dunite cut by dikes of decomposed granite, numerous dikes of pegmatite, and veinlets of magnesite. The largest ore body in the deposit was reported to be 6 by 10 feet in cross section and more than 100 feet long. This body was mined from the underground workings and its attitude must have been nearly vertical. Numerous small unconnected lenses of ore, as well as some disseminated chromite, occurred in the soft serpentine excavated from the open cut. Some ore is reported to be present in the underground workings, but these workings are caved and no attempt has been made to reopen them in recent years.

Mr. Fredericks began his operations on the old dumps, which he said were composed of about 50 percent chromite and about 50 percent waste. Some lump ore was hand picked from this material before and during the milling procedure. After the dumps had been cleaned up and milled it was found that the clayey soil beneath them contained considerable chromite, presumably derived from the weathering of the original outcrop of the deposit. This chromite-rich soil also was milled.

The mill employed a simple gravity concentration process using a stamp crusher and a series of screens, jigs, and tables (see fig. 4). The tailings were impounded behind an earth-filled dam and were re-treated after the mill had been remodeled for that purpose. Ores from the Lacey and Gardner mines were treated in the mill also.

The Clara H mine has been the largest producer of chromite in Fresno County. Production of the mine prior to 1916 has not been recorded. In 1916 the mine yielded 3,571 long tons of ore. A part of the 1,574 long tons of ore purchased by H. S. Doyle and L. R. Payne in 1918 came from the Clara H deposit, but the exact amount is not known. Recent production amounted to 15 long tons in 1940, 728 long tons in 1941, 496 long tons in 1942, 11 long tons in 1943, 81 long tons in 1944, and 16 long tons in 1945—a total of 1,347 long tons, of which 892 long tons were concentrates. The total accredited production is therefore 5,918 long tons, but the actual production probably is between 7,000 and 8,000 long tons.

No analyses of the pure chromite from this deposit are available. It is not likely that the pure mineral exceeds 50 percent Cr_2O_3, however, as the richest shipment of concentrates contained only 44 percent Cr_2O_3. The ores produced from 1942 to 1945 averaged 42.33 percent Cr_2O_3, and had a Cr:Fe ratio of 2.25. These figures, especially the Cr:Fe ratio, are believed to be characteristic for the deposit.

Inasmuch as the only ore known to remain in the deposit is an indefinite amount reported to be present in the now-caved underground workings, an estimate of reserves is not justified. However, the large past production would seem to warrant exploration below the present levels if the demand for high-iron ores is increased greatly. (Cater 43; Elliott 43; Rynearson 42; Wells 41; Toll 18; Taliaferro, in Louderback 18; Bradley 18, p. 145)

Saint Mine (22) [75]

R. E. Saint owned and operated a deposit of chromite in the NW¼ (?) SE¼ sec. 25, T. 11 S., R. 23 E. during World War I. The deposit was exploited by a shaft 50 feet deep and a drift, which was later stoped into an open cut 75 feet long and 40 feet deep near the shaft. The ore occurred as small masses of both hard and crumbly chromite in shattered serpentine. The serpentine is highly altered to talc and magnesite. A production of several carloads of ore is reported. Carload lots of the ore contained 41 to 46 percent Cr_2O_3. The deposit has been worked out. (Taliaferro, in Louderback 18; Toll 18)

Unidentified Mine (23)

The old workings of an unidentified chromite mine are in the SE¼ (?) sec. 25, T. 11 S., R. 23 E. An open cut 25 feet long, 8 feet wide, and 8 feet deep, and two small pits are aligned in a N. 60° E. direction. An adit driven 40 feet toward the cut was never completed. The cut is caved and no ore is exposed. About 150 feet up the hill is a shaft 10 feet deep which was sunk on a stringer of chromite 2 inches thick. (Cater 43)

Kirkland Lease (24)

A deposit of disseminated chromite in the SW¼ (?) sec. 25, T. 11 S., R. 23 E. was prospected by E. S. Kirkland in 1943. The only workings consist of several small open cuts, four trenches, and some bulldozer "scrapings." The chromite occurs as a zone of linear and planar banded streaks one crystal wide and 2 inches long in dunite. The planar element strikes N. 10°-80° W. and dips 60° NE. The linear element pitches 65° S. 45° E. The ore is very low in grade, and probably contains less than 10 percent Cr_2O_3. (Cater 43)

Unidentified Mine (26)

The old workings of another unidentified chromite mine are in the NW¼SW¼ sec. 30, T. 11 S., R. 24 E. 800 feet northeast of the Clara H mill (25). An open cut 60 feet long trending N. 47° E. and the caved remains of a drift constitute the only exploitation. No ore shows in the highly sheared serpentine, though pieces of medium-grained massive ore on the dump indicate some ore has been mined. (Cater 43)

Erickson Mine (27)

The Erickson mine is in the SW¼ sec. 30, T. 11 S., R. 24 E. on land belonging to R. E. Saint. It was operated by John Erickson in 1918. A former operator, name unknown, excavated an open cut 47 feet long which was partly underhand-stoped to a depth of 10 feet. Erickson sank a shaft 50 feet deep near one end of the cut, and intended to drift and stope on ore below the cut.

The ore occurred as a series of nearly vertical lenses along a ''slip'' in the serpentine. The largest of these lenses were 10 to 15 feet long and 2½ feet wide. Toll was told that ore was present in the bottom of the cut and that ore persisted from top to bottom of the shaft with a maximum thickness of 2 feet, though it generally was much thinner. The ore contained 38 to 39 percent Cr_2O_3. The total production is not known. Toll reported stocks of 20 long tons and estimated reserves of 200 long tons of indicated ore in 1918. This ore must have been mined and shipped as there was no ore exposed or on the dump in 1943. (Cater 43; Toll 18)

Doyle Lease (28)

A chromite deposit on deeded land belonging to R. H. Weldon was leased and operated by H. S. Doyle in 1918. The deposit is in the NW cor. SE¼ sec. 31, T. 11 S., R. 24 E. The workings consist of an adit 30 feet long trending north-northwest with a west crosscut 5 feet long. Taliaferro saw only a few thin stringers and small irregular masses of ore in place. About 3 long tons of ore was left on the dump. One carload of ore was mined and shipped in 1917. (Taliaferro, in Louderback 18)

Despot and Moreau Lease (29)

In 1918 S. Despot and L. Moreau leased and operated a deposit of chromite in the NW¼SW¼ sec. 32, T. 11 S., R. 24 E. on deeded land belonging to R. H. Weldon. The production amounted to only 20 or 30 long tons when the deposit had been worked out. (Taliaferro, in Louderback 18; Toll 18)

McMurtry Mine (30) [77]

The McMurtry or Bald Hill mine is in the SE¼ sec. 4, T. 12 S., R. 24 E., on deeded land belonging to Robert Weldon. The property was leased and developed by W. F. McMurtry during World War I. There are two deposits on the property. One is on the Bald Hill No. 1 claim in a small saddle in the SW¼SE¼ sec. 4, and the other is on the Bald Hill No. 2 claim in the NE¼SE¼ sec. 4 near the old Watts Valley road.

The Bald Hill No. 1 deposit is opened by a shaft 48 feet deep, a drift extending at least 30 feet east from the bottom of the shaft, and several small cuts in the hillside below the shaft collar. The underground workings are flooded. The ore occurred as a series of lenses of chromite connected by thin stringers of chromite. One lens containing about 16 tons of ore was found 12 feet below the surface. This lens pinched down to a narrow stringer which developed into a large lens that Taliaferro described as being a very irregular, pinching and swelling mass of chromite 2 to 6 feet thick exposed for 20 feet along the back and floor of the drift. In all probability, most of this ore was mined out before the mine was abandoned. About 25 long tons of ore was mined from several lenses in the cuts on the hillside. These ore bodies ranged from about 500 pounds to 5 or 6 tons. Two or three hundred long tons of ore averaging about 35 percent Cr_2O_3 was shipped from the deposit during World War I. The workings are inaccessible and no estimate of reserves can be made.

The Bald Hill No. 2 deposit consisted of a number of small, irregular lenses of ore in soft weathered serpentine. Between 25 and 50 long tons of ore was mined from two small pits on the claim. (Rynearson 42; Toll 18; Taliaferro, in Louderback 18)

Chrome Jade Group (32-34)

The Chrome Jade group of three claims is in the NE¼ sec. 8 and the NW¼ sec. 9, T. 12 S., R. 24 E. The claims are held jointly by C. E. Hull, E. E. Hull, A. E. Osborne, and J. W. Riffe. Information about these claims is very meager. They probably are analogous to claims formerly known as the Black Slide Chrome, Dead Sheep, and Moore claims. Half a dozen occurrences of chromite have been reported in the area covered by the claims, and a sled road was built to one claim during World War I. However, it is doubtful whether any of the deposits have been exploited much beyond the prospect stage. (Riffe 41; Taliaferro, in Louderback 18)

Jensen Group (35, 36, 50)

The Jensen group of claims consists of the Jensen No. 1 (36) [77] and No. 3 (35) claims in the N½SW¼ sec. 9 and the Jensen No. 4 (50) claim in the NW¼NE¼ sec. 23, T. 12 S., R. 24 E. The claims are held by C. E. Hull, et al. A sled road was constructed to deposits on the No. 1 and No. 3 claims during World War I. No other information is available about these two claims.

The Jensen No. 4 claim (50) [78] was known as the Henry Ford mine during World War I, when it was owned and operated by S. D. DeMasters. The workings consist of an open cut 65 feet long leading into an adit 30 feet long that opens into a glory-hole 10 feet in diameter at the bottom and 40 feet by 20 feet wide at the surface 30 feet above the adit. The ore apparently occurred as a nearly vertical series of lenses that had a northwesterly strike. The ore bodies lay near a decomposed granitic dike in the serpentine. Toll reported the deposit worked out in 1918. Various reports indicate the amount of ore mined and shipped was 200 to 500 long tons, all of which was mined in 1916 and 1917. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Little Rock Mine (37)

The Little Rock mine, also known as the Poison Oak mine, is on the crest of the Hog Mountain ridge near the line between secs. 9 and 10, T. 12 S., R. 24 E. James Kipp and T. C. Hole opened the deposit during World War I by an open cut and a short adit. Taliaferro did not see any unmined ore in the workings but reported that about 20 long tons of banded and evenly disseminated ore containing 20 to 30 percent Cr_2O_3 was stacked on the dump. (Taliaferro, in Louderback 18)

Rose Claims (38)

Frank Rose held eight claims in the SW¼ sec. 11, T. 12 S., R. 24 E. during World War I. Ore was found in place at two localities on these claims and float was found in several other places.

Taliaferro reported that one deposit consisted of a body of low-grade ore (30 percent Cr_2O_3) averaging 4 feet in width, which had been exposed along the strike for 20 feet, but that no ore had been mined. At the other deposit, 600 feet north, 40 long tons of ore containing 38 to 40 percent Cr_2O_3 had been mined from an irregular lens near the surface, and another lens 2½ feet wide and 3½ feet long had been exposed in the bottom of a shaft 15 feet deep. The total amount of ore eventually taken from these deposits is not known. (Taliaferro, in Louderback 18)

Jack Sprat Group (39-44)

The Jack Sprat group of six claims is on the south slope of Hog Mountain in the S½ sec. 10 and the N½ sec. 15, T. 12 S., R. 24 E. C. E. Hull, E. E. Hull, A. E. Osborne, and J. W. Riffe are joint owners. The claims include the Jack Sprat mine, operated by Frank Carson, A. D. Sweet, et al. during World War I, and the Nose, Black Joe, Lookout, Valley View, Black Bear, Open Cut, and three other claims, operated first by John Crisle and later by the D.L.W. Mining Company during World War I. The ore shipped from these deposits was sledded about 1 mile to the end of the Deer Creek road and then trucked about 6 miles to Piedra. Recent information is available only for the deposit on the Jack Sprat No. 1 claim. Inasmuch as the previous descriptions of the properties by Taliaferro and Toll cannot be correlated in all cases to the more recent claims, the descriptions which follow are headed by the older names and references are made to the newer names if possible.

Jack Sprat No. 1 (39) [*77*]. The Jack Sprat No. 1 deposit, also known as the Jack Sprat or Carson and Sweet mine, is at an altitude of about 2600 feet on the crest of a small spur in the S½SW¼ sec. 10, T. 12 S., R. 24 E. The main workings consist of an open cut 70 feet long and 20 feet wide, a shaft, and a winze (see fig. 5). A small prospect pit was dug about 150 feet southwest of the main workings. The underground workings were inaccessible in 1942, but when Taliaferro and Toll visited the mine in 1918 the winze was 10 feet deep and the shaft was 125 feet deep and pitched 80° W. Taliaferro also noted several small, irregular tunnels, which are presumed to have been in the sides of the cut when it was smaller than at present.

The ore occurs in a narrow zone as a series of stringers and small pods of nearly massive chromite, some of which are ''frozen'' to the serpentine wall rock. The individual masses of ore range in thickness from a quarter of an inch to a maximum (reported) of 8 feet, and the largest mined is said to have been about 15 feet long. The ore zone is nearly vertical and strikes about S. 80° W. It has been exposed for 75 feet along the strike on the surface, and ore is said to be present in the bottom of the winze and in the ribs of the shaft from top to bottom. It is not likely that the small amount of chromite in the prospect pit southwest of the main workings represents a continuation of the main ore zone, although this possibility could not be disproven definitely because of poor exposures.

Mr. C. E. Hull believes approximately 2,000 long tons of crude ore was shipped from this mine during World War I, but Toll reported the production to be only 800 long tons at the time of his visit. Mr. Hull's estimate probably represents the total shipments from the various Carson and Sweet properties, while Toll's 800 tons, plus perhaps another 50 to 100 tons mined before cessation of operations, probably is a more accurate estimate of the production of this mine. The ore averaged only

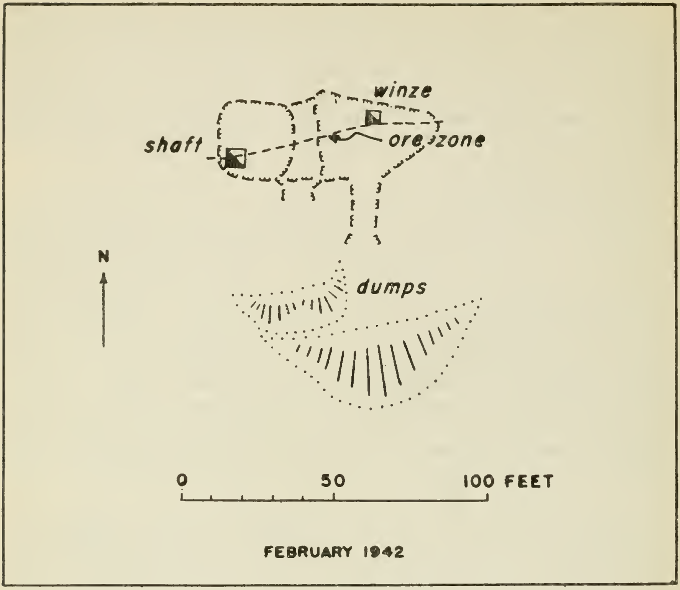

FIGURE 5. Geologic sketch map of the Jack Sprat No. 1 chromite deposit, Fresno County, California.

about 30 percent Cr_2O_3 because of considerable serpentine in the matrix; it was therefore "sweetened" with ores of higher tenor from other properties before shipment.

The only measurable ore on the property amounts to about 1 ton visible in the outcrop and 15 to 20 tons stacked on the dumps. On the assumptions that the ore zone is continuous between the collars and bottoms of the shaft and winze, with an average thickness of 2 feet of ore, and that an appreciable amount of such ore has not been stoped already, reserves of indicated ore are about 600 long tons. A like amount of ore also may be inferred from the possible extension of the ore zone beyond the indicated limits, thus making the total reserves of all classes slightly in excess of 1,200 long tons. Although some "fines" are present on the surfaces of the dumps, it is probable that the interiors of the dumps consist largely of waste. Because of the low tenor of the crude ore, it would have to be mixed with ore of higher tenor or be concentrated by a milling process even to meet the unusually low specifications of emergency periods. (Rynearson 42; Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Nose Mine (41). The deposit formerly known as the Nose mine is situated in the overlap of the Jack Sprat No. 3 and No. 4 claims. It is near the top of a small spur at an altitude of 2400 to 2500 feet in the SE¼NW¼ sec. 15, T. 12 S., R. 24 E. Taliaferro and Toll reported the workings consisted of an open cut 50 feet long trending N. 42° W. and an incline or winze 45 to 50 feet deep pitching 65° N. 65° E. The mine was abandoned after two carloads, or less than 100 long tons of ore, had been mined and shipped. No ore remains in the workings. No reserves are indicated, although additional prospecting might disclose other ore bodies. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Black Joe Mine (42) [*78*]. The deposit formerly known as the Black Joe mine is adjacent to the old Nose mine and on the Jack Sprat No. 4 claim. It is at an altitude of about 2400 feet in the SE¼NW¼ sec. 15, T. 12 S., R. 24 E. When Toll visited the property the workings consisted of an open cut 27 feet long, an adit 33 feet long, and a winze 35 feet deep. An ore body 2½ feet thick was being mined from the winze at the rate of about 2 tons per day. The total production of this mine probably did not exceed 50 long tons of ore, which averaged about 40 percent Cr_2O_3. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Lookout Mine (43). A prospect, once called the Lookout mine, is on the Jack Sprat No. 5 claim about 300 feet northeast of and at the same altitude as the Black Joe mine. It is in the NW¼NE¼ sec. 15, T. 12 S., R. 24 E. The property was abandoned before Taliaferro made his examination. He noted a few very small lenses of chromite in an open cut 40 feet long and 8 feet wide. The long dimension of the cut was parallel to the schistosity of the serpentine, which trends N. 50° W. and dips 75° N. The amount of ore shipped, if any, is not known and no reserves are indicated. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Valley View Mine (44). The old Valley View mine is on the Jack Sprat No. 6 claim northeast of the Lookout mine. The workings are located at the head of a small gulch in the S½SE¼ sec. 10 and the N½NE¼ sec. 15, T. 12 S., R. 24 E. Taliaferro reported that the only exploitation was a shaft 35 feet deep, whereas Toll reported an open cut 25 feet long, an adit 20 feet long, and a shallow winze 3 feet deep. They probably reported different workings on the same property as later information indicates several deposits were found on the claim.

Taliaferro saw a lens of ore 2 feet wide 20 feet below the collar of the shaft and estimated 5 long tons of ore in sight, not including 10 long tons of ore (34 percent Cr_2O_3) already mined. The mine was idle when Toll visited it a month later. Apparently he saw no ore in place, but he was informed that the largest ore body mined had been 20 feet long, 8 feet wide, and 4 to 5 feet thick, and that the past production had been one carload of ore. No reserves are indicated. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Saddle Blanket Group (45-49)

The Saddle Blanket group of five claims is in the SW¼ sec. 14 and the S½NE¼ sec. 15, T. 12 S., R. 24 E. These claims are held by C. E. Hull, et al., but include deposits known as the Wedge, Black Hawk, Tippecanoe, and Surprise mines which were owned and operated by Frank Carson, A. D. Sweet, et al. during World War I. The earlier names are used in the following descriptions, as the exact correlation of the old and new names is not known.

Wedge Mine. Two deposits were opened on the Wedge property. The "Discovery" workings consist of an open cut 25 feet long and an adit 25 feet long. A number of small irregular masses of ore were mined from these openings. The "New Find" workings consist of an open cut 20 feet long, 20 feet wide, and about 15 feet deep and a shaft 8 feet deep at the inner end of the cut. Toll reported that the ore exposed in the bottom of the shaft was 14 inches thick at the time he examined the property. The mine yielded 250 long tons of ore. (Riffe 41; Toll 18)

Black Hawk Mine [*78*]. Two deposits were worked on the Black Hawk property. The upper workings consist of an open cut 60 feet long, 26 feet wide, and 25 feet deep at the face, and an adit 43 feet long which trends N. 65° W. for 35 feet, then S. 25° W. for 8 feet. The lower workings consist of an open cut 20 feet long at the portal of an adit 30 feet long and an open cut 15 feet long 40 feet below an adit 5 feet long. The ore occurred as small lenses and irregular masses in dense, hard serpentine. Mining operations ceased in 1915 after 300 long tons of ore in the upper workings and 100 long tons of ore in the lower workings had been mined and shipped. Very little ore was left exposed in the workings. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Tippecanoe Mine. The Tippecanoe deposit was mined by one open cut 30 feet long and 15 feet wide 10 feet above another open cut 21 feet long at the entrance to an adit 40 feet long. According to Toll, the ore body in this deposit was 12 feet wide at the surface but narrowed to 3 feet, then swelled to 8 feet where it was cut off by a granite dike. No ore was found on the other side of the dike. This was the largest individual ore body found in the group of deposits, and yielded 250 long tons of ore. (Riffe 41; Toll 18)

Surprise Mine. The workings at the Surprise mine consist of an open cut 31 feet long, an adit 22 feet long, and a winze whose depth is not known. The ore occurred along a zone that strikes N. 15° E. Toll was told that an ore body 3 feet wide remained in the bottom of the winze, but operations were discontinued in 1916 after 50 long tons of ore had been mined and shipped. (Riffe 41; Toll 18)

Chrome Gulch Group (51-54)

The Chrome Gulch Nos. 1, 2, and 3 claims and the Top Notch claim (51) are in secs. 14, 23, and 24, T. 12 S., R. 24 E. near the common section corner. These claims include four or five occurrences of chromite, of which the two principal ones are thought to be identical with properties described by Taliaferro and Toll as the Carson property and the Black Chief mine. Frank Carson worked the former and S. D. DeMasters was the most recent operator of the latter. The present claims are held by C. E. Hull, et al.

Taliaferro reported "considerable development" at the Carson mine, but the mine was abandoned and the workings caved at the time he made his examination. Several carloads of ore were shipped from the deposit in 1916 and 1917.

Toll described the workings of the Black Chief mine as an open cut 30 feet long and a shaft which was then 50 feet deep. The ore occurred as a series of small lenses along a nearly vertical east-trending shear zone in the serpentine. Two carloads of ore containing about 40 percent Cr_2O_3 was taken from the open cut by early operators. DeMasters sank the shaft 46 feet on the shear zone before finding an appreciable amount of ore, and he was mining a lens of ore 3 feet thick when Toll made his visit. It is possible that another carload of ore was extracted during the last operations. (Riffe 41; Toll 18)

Red Slide Claims (55, 56) [78]

The Red Slide No. 1 and No. 2 claims are at an altitude of about 1600 feet near the center of the line between secs. 23 and 24, T. 12 S., R. 24 E. C. E. Hull, et al. are the owners. No detailed information is available on the No. 1 deposit. The No. 2 deposit was known as the Vance or Woodrow Wilson mine during World War I when it was operated by the Vance Brothers. The workings consist of several small open cuts, a tunnel at least 40 feet long, a winze at least 10 feet deep, and several short raises from the tunnel to the surface.

The chromite occurred as irregular lenses of nearly massive ore. Some of the lenses had disseminated ore along their borders. The thickness of the ore ranged from a narrow seam to 4 feet; the largest ore body mined was about 20 feet long and 15 feet wide. The mine yielded 200 to 250 long tons of ore containing about 42 percent Cr_2O_3. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Thelma Group (58-60)

The Thelma group of three claims is in the SE¼NW¼ and the NE¼SW¼ sec. 24, T. 12 S., R. 24 E. It includes the old Thelma mine, which was worked by Frank Carson and John Bittern during World War I, and two other deposits for which descriptive information is lacking. C. E. Hull, et al. now hold the claims. The Thelma mine was exploited by a tunnel trending N. 25° E. for 75 feet to connect with a shaft 30 feet deep, and some stopes. Only a few tons of mined and unmined ore was left in the deposit in 1918. It is said this mine yielded several carloads of ore. (Riffe 41; Taliaferro, in Louderback 18)

Long Ledge Group (61-64) [78]

The Long Ledge group of four claims is on the southeast end of Hog Mountain in sec. 24, T. 12 S., R. 24 E. and sec. 19, T. 12 S., R. 25 E. C. E. Hull, E. E. Hull, A. E. Osborne, and J. W. Riffe are joint owners. The claims include three mines that were well known in the district during World War I: the Wood's or Grizzly Bear mine, operated by G. E. Wood and John McGirr; the Riverview mine, operated by Wm. Terrill; and the Black Bear mine, operated by Frank Rose. Other claims originally located in the same area included the Humming Bird, High Pocket, Cub Bear, and Flat Iron. It is not known how the latter correlate with present locations, but they may represent several minor prospects for which no detailed information is available. The ores mined from these deposits during World War I were sledded to the old Trimmer road and then trucked to Piedra or to an old mill near Trimmer. Detailed descriptions of the three larger deposits follow.

Long Ledge No. 1 (61). The Long Ledge No. 1 deposit, formerly known as the Wood's or Grizzly Bear mine, is at an elevation of about 1750 feet in the SE¼NE¼ sec. 24, T. 12 S., R. 24 E. near the township line. The workings consist of three open cuts, some open stopes connected by short tunnels, and two adits (see fig. 6). The upper cut is 70 feet long and 10 feet wide. The lower cut is 85 feet long and 10 to 15 feet wide. The central cut is only 20 feet long and about 8 feet wide. Open stopes, some of which are 30 feet high, open into the two larger cuts. An adit 60 feet long was driven into the north face of the upper cut. Another adit was driven 80 feet N. 48° W. through barren serpentine in an attempt to intersect the ore zone about 100 feet below the north end of the lower cut.

The ore zone consists of a more or less continuous series of stringers and lenses of nearly massive chromite enveloped by serpentinized dunite containing disseminated and nodular chromite. The total thickness of the zone is about 10 feet; the massive ore ranges from 1 inch to 6 feet in thickness and averages less than 2 feet. At the south end of the zone the massive ore grades into ore consisting of closely packed nodules of chromite about a quarter of an inch in diameter. In general, the massive ore is sharply defined from rather than gradational into the disseminated

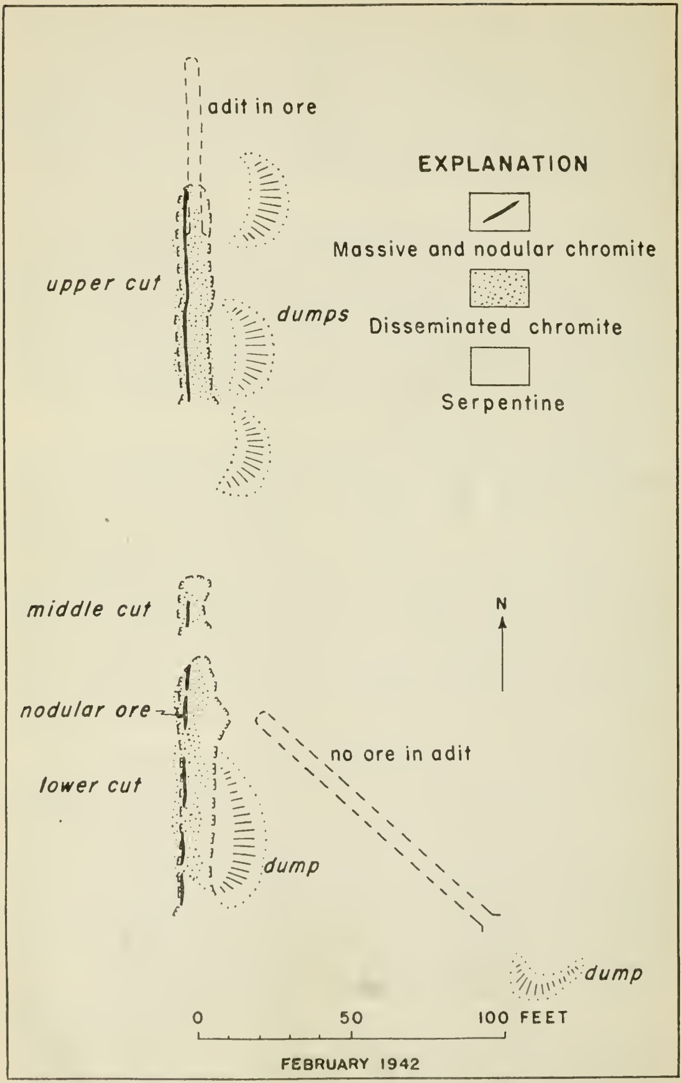

FIGURE 6. Geologic sketch map of the Long Ledge No. 1 chromite deposit, Fresno County, California.

ore. The zone strikes north, with local variations to N. 15° W., and dips about 80° E. It has been exposed for about 275 feet along the strike through a vertical range of about 75 feet. Linear structures in the disseminated ore indicate a nearly horizontal attitude for the long axis of the zone, and the upper limit of the zone appears to trend horizontally beneath the surface of the hill at the north end of the upper cut.

Approximately 250 long tons of ore averaging 33 percent Cr_2O_3 has been shipped from the deposit. About half of this ore came from the upper workings and averaged 42 percent Cr_2O_3. All the lump ore shipped had to be hand-sorted to bring the tenor up to 30 percent Cr_2O_3, as the massive ore, as mined, only averages about 25 percent Cr_2O_3. The disseminated ore is estimated to contain 10 percent chromite, the equivalent of less than 5 percent Cr_2O_3. An attempt to concentrate some of the crude ore in a converted gold mill near Trimmer met with little success because of the low efficiency and high cost of the operation. Some concentrates were produced, however, but their tenor is not known.

Inasmuch as structures in the ore indicate that the long axis of the ore body is horizontal, it is reasonable to assume the ore at the north end of the deposit persists to a depth level with the south end. Therefore, an ore block 275 feet long with an average depth of 25 feet is indicated. If the average thickness of the massive ore is 18 inches, reserves of about 1,000 long tons of ore containing 25 percent Cr_2O_3 are indicated. Some of this ore undoubtedly could be sorted to a shipping grade, but the bulk of it must be considered milling-grade ore. Therefore, it seems best to state the reserves of this deposit in terms of milling-grade ore, and on that basis the disseminated ore should be included, as considerable chromite could be obtained from this source. Thus, using an average thickness of 10 feet for the whole zone, the indicated reserves are approximately 6,800 long tons of ore estimated to contain 5 to 10 percent Cr_2O_3. In addition, 1,000 to 1,500 long tons of similar rock in the dumps could be milled. The total reserves of indicated milling-grade ore are therefore about 8,000 long tons. Although much larger reserves of ore might be inferred, the geologic evidence at hand does not seem to warrant such an estimate. An extension of 50 feet in the lower adit, to prove or disprove the possible continuity of ore to the adit level, should provide information for making a further evaluation of this deposit. (Rynearson 42; Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Long Ledge No. 2 (62). The Long Ledge No. 2 deposit, formerly known as the Pearson property or Riverview mine, is across a small gulch and below the Long Ledge No. 1 in the NW¼SW¼ sec. 19, T. 12 S., R. 24 E. Taliaferro and Toll reported that the workings consisted of an open cut, an adit trending S. 60° E. for 50 feet then east for 10 feet, and a winze at least 35 feet deep in the end of the adit. It is probable that most of the underground workings are now inaccessible.

A dike of medium-grained biotite granite strikes N. 50° E. and dips 85° SE. in the serpentine near the entrance of the adit. Taliaferro noted a small lens of chromite in the adit near the portal but saw no ore in the winze, then only 10 feet deep. Ore apparently was encounted at a greater depth in the winze, as the mine was in production when visited by Toll a month later. Two carloads of ore containing about 40 percent Cr_2O_3 were shipped in 1917 and another carload was shipped in 1918. The total production therefore is approximately 150 long tons. (Riffe 41; Toll 18; Taliaferro, in Louderback 18)

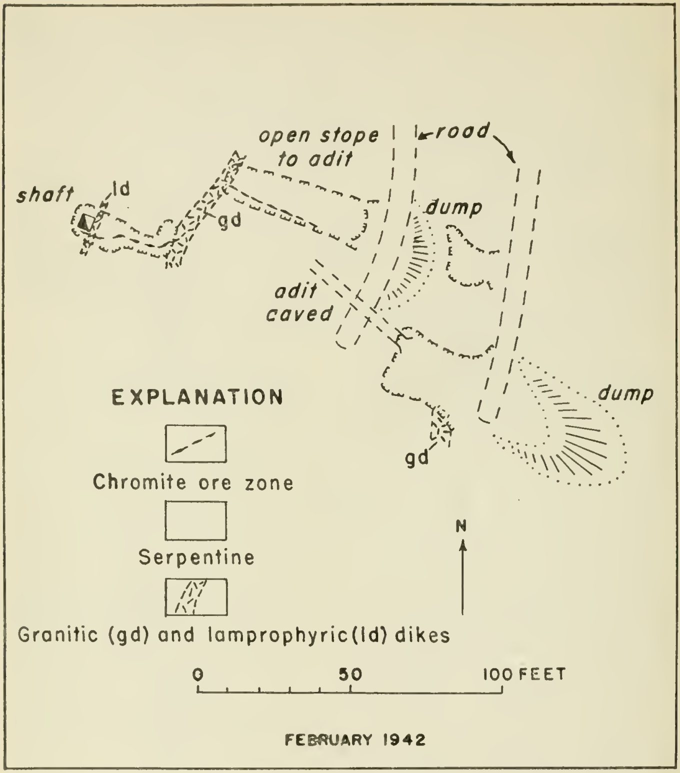

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FIGURE 7. Geologic sketch map of the Long Ledge No. 3 chromite deposit, Fresno County, California.

Long Ledge No. 3 (63). The Long Ledge No. 3 deposit, previously known as the Black Bear mine or Rose lease, is at an altitude of about 1000 feet on a small spur in the S½SW¼ sec. 19, T. 12 S., R. 25 E. The workings consist of an irregular open pit 35 feet long and 5 to 10 feet wide, formed around the collar of a shaft 25 feet deep; an open cut 50 feet long and 10 to 12 feet wide; an adit (now caved) about 75 feet long; an open stope connecting the large open cut and the adit; and two small open cuts (see fig. 7). Some caved underground workings are located across the Trimmer road northwest of the main workings. No information is available on the nature or extent of these workings.

The ore occurs in a well-defined zone in the serpentine as thin stringers and small lenses of chromite that range from an inch to several feet in thickness. The zone strikes about N. 80° W. and dips 60° SW and is parallel to a rudely developed schistosity in the serpentine. The deposit is only a few hundred feet west of an intrusive mass of gabbro. Three intrusive dikes are exposed in the surface workings. One near the shaft is fine grained and lamprophyric. Another is granitic and occurs in a fault zone which offsets the ore zone 10 to 15 feet between the open pit and the large open cut. The third dike is also granitic and is poorly exposed in the open cut at the portal of the adit.

Small stringers of ore are present in the open pit and large open cut. Toll reported ore present in the floor of the adit and was told that ore 2 feet thick had been found in a shallow winze (filled) in the adit. The shaft was inaccessible when last visited (1942) so the amount of ore exposed, if any, is not known.

The production of the mine is reported to be about 450 long tons of ore, the richest of which contained about 38 percent Cr_2O_3, but some contained only 30 to 32 percent Cr_2O_3. No ore is blocked out and very little is indicated. However, it can be inferred that further development might lead to the production of as much as three or four hundred long tons of ore containing 30 to 35 percent Cr_2O_3 (Rynearson 42; Riffe 41; Toll 18; Taliaferro, in Louderback 18)

Terrill Property (65, 66)

Wm. Terrill held four claims in secs. 18 and 19, T. 12 S., R. 25 E. during World War I. Two of the claims were in a narrow outlier of the main peridotite sill. About 10 long tons of ore was mined from one of the claims. No other information regarding the deposits is available. (Taliaferro, in Louderback 18)

Cripe Property (67)

L. W. Cripe owned and operated a deposit of chromite (East Side Red Dome claim?) in the NW¼SW¼ sec. 8, T. 12 S., R. 25 E. Taliaferro reported that the ore occurred as small lenses in a serpentine inclusion in granite. At one place there was a small, irregular body of chromite at the contact of the serpentine and granite. Mr. Cripe mined about 13 long tons of ore from the deposit in 1918, but it is not known if the ore was shipped. (Taliaferro, in Louderback 18)

Snyder Property (69)

F. M. Lewis and C. B. Keller mined a deposit of chromite on the property of Vera Snyder in sec. 31 (?), T. 12 S., R. 24 E. An open cut about 15 feet long and 5 feet deep constituted the only exploitation. The ore was sledded over a steep trail to the Piedra-Pine Flat road.

The ore occurred as small lenses in talcose serpentine. A well-developed schistosity in the serpentine strikes N. 10°-15° W. and is nearly vertical. One lens of ore mined was 2 feet wide and 4½ feet long. About 20 long tons of ore was mined and shipped during 1917 and 1918. It is assumed that the deposit has been mined out. (Taliaferro, in Louderback 18; Bradley 18, page 145)

Houghton Property (70)

J. B. and R. T. Houghton owned and operated a chromite deposit (Spike Buck claim?) in the SW¼ sec. 34, T. 12 S., R. 25 E. (see fig. 2). Taliaferro reported the only workings consisted of several small open cuts. The deposit occurs in a small body of serpentine lying between granite and schist. Some massive ore was found as float, but none was found in place. Taliaferro noted that the serpentine contained 5 to 20 percent chromite in some places and, although little work had been done, he estimated the deposit to have at least 250 long tons of ore containing a little less than 5 percent Cr_2O_3. The Houghton brothers shipped 18 long tons of ore in 1918. (Taliaferro, in Louderback 18)

Tulare County

Detailed information is available for only eight chromite deposits in Tulare County. A few other chromite occurrences have been reported, but the location and extent of work done, if any, are not known. Nearly all the chromite yielded by deposits in the county was mined during World War I. No production has been reported since 1919, indicating that no new deposits have been found and that reserves of the known deposits are negligible. Areas underlain by ultramafic rocks are small and readily accessible, so it is probable that the areas have been thoroughly prospected and it is not likely that any important deposits will be found in the future.

Gill Mine (Gill Ranch) (1) [80]

The Gill mine, or Gill Ranch mine, is in the SE¼NW¼ sec. 16, T. 19 S., R. 27 E. on land owned by the Gill Brothers Cattle Company. Alva Joyner operated the property in 1917 and Frank Carson, A. D. Sweet, et al. operated it in 1918. The workings consist of open cuts and tunnels ranging in length from 35 to 90 feet, and a shaft about 35 feet deep. No mining has been done since 1918.

The ore occurred as a more or less continuous series of lenses along a zone striking southeast. The general dip of the ore bodies was vertical, but locally the dip was as low as 50° SW. The lenses varied considerably in size; the largest was about 2 feet thick, 10 or 12 feet deep, and 30 feet long. The serpentine wall rock contains bands of talc and narrow seams of magnesite and chlorite. Toll reported that Joyner shipped three cars of ore from the mine and Carson and Sweet, et al. shipped four cars. Ore was still being mined at the time, so another carload may have been mined and shipped. Total production probably amounted to approximately 400 long tons of ore containing about 40 percent Cr_2O_3. No reserves are estimated. (Toll 18)

Bowlin Mine (2) [81]

Lee Bowlin mined a deposit of chromite in the northwest corner of sec. 20, T. 19 S., R. 27 E., on land owned by the Gill Brothers Cattle Company. The workings consist of a small pit, an open cut 60 feet long, 6 feet wide, and 3 to 6 feet deep, and a shaft about 25 feet deep from which two short drifts extend. The underground workings are flooded.

Two lenses of ore, one above the other, occurred in highly fractured, serpentinized dunite seamed with magnesite. The strike of these lenses was easterly and their dip was vertical. The ore was massive, but the grade is not known. About 100 long tons of ore was mined and shipped before the deposit was worked out in 1916. (Cater 43; Tucker 16, p. 906)

Waddell Mine (3, 5)

Two chromite deposits, one in the SW¼ sec. 17 and another in the NW¼ sec. 20, T. 19 S., R. 27 E., were operated in 1916 and 1917 under a lease from Frederick Gill. Each deposit consisted of a series of narrow lenses of ore striking northeast in serpentine. The deposits yielded 70 long tons of ore in 1916 and 40 long tons of ore was sorted from the dumps in 1917. Both deposits have been worked out. (Franke 30, p. 432; Bradley 18, p. 213; Tucker 16, p. 907)

Sattlefield Mine (4)

The Sattlefield chrome mine is reported to be in sec. 20, T. 19 S., R. 27 E., probably in the northern part of the section. The workings consist of two open cuts. About 75 long tons of ore was mined from north-striking lenses 2 to 5 feet wide. No other information concerning this mine is available. (Tucker 16, p. 906)

Earl Smith Mine (6)

The Earl Smith chrome mine was examined by Toll in 1918. He gave the location as being on a "hogback" running easterly (northeasterly?) from Lindsay Peak, which would indicate its location is in the S½ sec. 21 or the NW¼ sec. 28, T. 19 S., R. 27 E. The property was leased by Earl Smith from Fred and Will Gill, and was operated from 1916-18. Smith claimed he had found ore in place at 16 different localities in the area, but he had opened only one of the deposits. The workings at this deposit included several small open cuts, a tunnel 50 feet long, and a shaft 30 feet deep.

The deposit apparently consisted of three lenses, or groups of lenses, of ore about 100 feet apart, all having a northwest strike and a nearly vertical dip. Most of the ore mined was almost massive and contained about 40 percent Cr_2O_3, but some contained as little as 30 percent Cr_2O_3 because of greater amounts of interstitial serpentine. Toll reported the production to be 75 long tons in 1916, 30 long tons in 1917, 50 long tons in 1918, and 50 to 75 long tons mined and ready for shipment. The total production probably amounted to about 250 long tons, and it is assumed that the deposit was worked out in 1918. (Toll 18)

Gill Mine (7)

Another deposit also known as the Gill mine is in the NE¼SE¼ sec. 22, T. 19 S., R. 27 E. at an altitude of about 850 feet, on property owned by the Gill Brothers Cattle Company. The workings consist of 90 feet of tunnels and crosscuts, and three raises to the surface. Although no ore now remains in place, the workings indicate that a vertical lens of ore having a northerly strike and a width of about 4 feet was mined. Contacts of the ore body with the enclosing serpentinized dunite were sheared. Neither the tenor nor the amount of ore mined is known. About 4 long tons of ore mined during World War I remained on the dump in 1943. (Cater 43)

James Mine (8) [82]

The James mine is in the S½ sec. 11, T. 21 S., R. 27 E. It was owned by Mrs. J. H. James and was operated by R. O. Adams in 1915 and 1916. The deposit yielded 175 long tons of ore and was reported worked out in 1916. (Tucker 17)

Holston Mine (9) [83]

The Holston mine, also known as the Vaughn mine or Vaughn Ranch deposit, is in the S½ sec. 9, T. 22 S., R. 28 E., at an altitude of about 1,000 feet. Mrs. Charles Holston is the owner. The property was first operated during the middle nineties, and it is said that one carload of ore was shipped at that time. Several operators mined ore from the deposit from 1915-18, but the mine has been idle since.

Three groups of ore bodies were found on the property. The north workings consist of an open cut 100 feet long, 5 to 10 feet wide, and 4 to 15 feet deep, and some tunnels that are caved. The east workings consist of a tunnel 75 feet long to the bottom of a glory-hole 45 feet long, 10 feet wide, and 20 feet deep. The southwest workings include a large pit 60 feet long, 30 feet wide, and 15 feet deep at the uphill end.

The ore occurred as series of lenses in narrow, schistose serpentine bodies lying between small diorite or gabbro masses. These lenses of ore had strikes of N. 20°-30° W. and dipped about 70° SW. They were parallel to the schistosity of the serpentine, which in turn is parallel to the elongation of the serpentine bodies. Most of the contacts between the ore and serpentine were sheared, but in a few places they were frozen. The lenses in the north workings were offset about 8 feet by several faults striking N. 70° E. and dipping 50° NW. Very little ore remains in place in the workings. Some of this is spotted ore, but it is believed that the major part of the ore mined was massive, containing from 45 to 50 percent Cr_2O_3. Records of the California Division of Mines show the production of this mine to be 2,500 long tons in 1916, 370 long tons in 1917, and 312 long tons in 1918. A little ore may have been produced in 1915. The 94 tons of ore reported as stocked at the end of 1918 may have been shipped in 1919, as there was no evidence of this ore on the property in 1943. The total production of the mine is probably about 3,300 long tons. No reserves are indicated, but further exploration might lead to the discovery of additional ore bodies. (Cater 43; Franke 30, p. 432; Bradley 18, pp. 104, 213; Tucker 16, p. 907)

ALPHABETICAL LIST OF CHROMITE MINES AND PROSPECTS

All the known chromite mines and prospects are listed alphabetically by county in tables 3 and 4. Because many of the properties have been known by two or more names, all the names are listed, but the newest names are given preference and the older names are referred to them. Ownership of the properties is given as of the date of the last report on the deposit and, therefore, few of the current owners may be indicated. The map numbers given are those shown on figure 1 and plates 6 and 7. The deposits are assigned letters corresponding to four classes of production: A, deposits from which at least 1,000 long tons of ore has been shipped; B, deposits from which 150 to 1,000 long tons of ore has been shipped; C, deposits from which small amounts of ore, but not more than 150 long tons have been shipped; and D, deposits from which no ore has been shipped.

Table 3. Alphabetical list of chromite mines and prospects in Fresno County, California

Map No.	Property	Owner	Location			Class by production*	Remarks
			Section	Twp.	Range		
1	Alice	J. W. Hazelton	SW¼ SW¼ 13	11S	23E	C	Probably mined out
	Bald Hill Nos. 1 and 2: See McMurtry	R. W. Weldon					
13	B.B.	Bertha Linderman, et al.	SW¼ 24	11S	23E	B	Mined out
	Big Pine	H. S. Doyle, et al. (Fresno Chrome Co.)	(?)	11S	23E		Location or production not known
	Black Bear: See Long Ledge No. 3						
10	Black Bow (Avery)	O. G. Avery	SE¼ NE¼ (?) 23	11S	23E	C	Low-grade massive ore
9	Black Bow (Strassbaugh)	H. Strassbaugh	NW¼ NW¼ 24	11S	23E	C	Some nodular ore. Mined out
	Black Chief: See Chrome Gulch Group						
	Black Hawk: See Saddle Blanket Group						
	Black Jack Nos. 1 and 2: See Chrome Jade Group						
	Black Joe: See Jack Sprat No. 4						
68	Black Mammoth Nos. 1 and 2	J. S. and J. W. Riffe, et al.	30	12S	24E		Prospected only
	Black Slide: See Chrome Jade Group						
12	Blue Brush	E. Wolfe	NW¼ SW¼ 24	11S	23E	C	Mined out
**	Blue Diamond	N. H. Joyner	------	------	------	C	Only 1 ton shipped. 55 percent Cr_2O_3
8	Brown Bird	H. S. Doyle, et al.	On line between 23 and 24	11S	23E	C	
	Buck Horn: See Little Rock						
17	Camden	Lavensaler-Speir Corporation	SE¼ NE¼ 26	11S	23E		Mined out
	Carson Property: See Chrome Gulch Group						
52	Chrome Gulch No. 1	C. E. Hull, et al.	NE¼ NE¼ 23	12S	24E	B	Formerly Black Chief or Carson
53	Chrome Gulch No. 2	C. E. Hull, et al.	NW¼ NW¼ 24	12S	24E	D	
54	Chrome Gulch No. 3	C. E. Hull, et al.	NW¼ NW¼ 24	12S	24E	B	Formerly Carson or Black Chief
32	Chrome Jade No. 1	C. E. Hull, et al.	NE¼ NE¼ 8	12S	24E	D	Probably just prospects
33	Chrome Jade No. 2	C. E. Hull, et al.	NW¼ NW¼ 9	12S	24E	D	
34	Chrome Jade No. 3	C. E. Hull, et al.	SW¼ NW¼ 9	12S	24E	D	
21	Clara H	Spear & Loffinger	SE¼ NW¼ 25	11S	23E	A	Produced 6,650 tons. Some ore in caved workings
25	Clara H Mill	R. A. Fredericks	SW¼ SW¼ 30	11S	23E		
	Collins: See Little Oak						
	Condon Peak: See Jeanne						

Table 3. Alphabetical list of chromite mines and prospects in Fresno County, California—Continued

Map No.	Property	Owner	Location			Class by production*	Remarks
			Section	Twp.	Range		
67	Cripe Property	L. W. Cripe	NW¼ SW¼ 8	12S	25E	C	
29	Despot-Moreau Lease	R. W. Weldon	NW¼ SW¼ 32	11S	24E	C	Mined out
7	Dolly Varden	J. J. Harkens	NE¼ NE¼ 23	11S	23E	C	
28	Doyle Lease	R. W. Weldon	NW cor. SE¼ 31	11S	24E	C	Few small stringers of ore left
	Eagle Nos. 1 and 2: See Terrill Property	W. L. Terrill					
	East Side Red Dome: See Cripe Property						
	Ely and Gibons No. 1	W. Ely and W. Gibons	(?)	11S	23E	C	Location not known. Mined out?
	Ely and Gibons No. 2	W. Ely and W. Gibons	SE cor. (?) 24	11S	23E	C	Probably mined out. Location uncertain
27	Erickson	R. E. Saint	SW¼ SW¼ 30	11S	23E	C	Mined out
57	Exposed View	C. E. Hull, et al.	NE¼ SE¼ 23	12S	24E	C	
	Franks Property: See Thelma Group (?)						
	Gardner		(?)			C	Location or owner not known
	Grizzly Bear: See Long Ledge No. 1						
	H. H.: See Powers						
	Henry Ford: See Jensen No. 4						
70	Houghton Property	J. B. and R. T. Houghton	SW¼ 34	12S	25E	C	Some disseminated ore
39	Jack Sprat No. 1	C. E. Hull, et al.	S½ SW¼ 10	12S	24E	B	Fair prospect for milling ore
40	Jack Sprat No. 2	C. E. Hull, et al.	SE¼ SW¼ 10	12S	24E	D	Prospected only. Poor outlook
41	Jack Sprat No. 3	C. E. Hull, et al.	SE¼ NW¼ 15	12S	24E	C	No reserves indicated
42	Jack Sprat No. 4	C. E. Hull, et al.	SE¼ NW¼ 15	12S	24E	C	Mined out?
43	Jack Sprat No. 5	C. E. Hull, et al.	NW¼ NE¼ 15	12S	24E	C	No reserves indicated
44	Jack Sprat No. 6	C. E. Hull, et al.	On line between SE¼ 10 and NE¼ 15	12S	24E	C	No reserves indicated
**	Jeanne	Aurora Quicksilver Company	36	18S	13E	C	High-grade ore in small lenses and float
36	Jensen No. 1	C. E. Hull, et al.	N½ SW¼ 9	12S	24E	C	
35	Jensen No. 3	C. E. Hull, et al.	NE¼ SW¼ 9	12S	24E	C	
50	Jensen No. 4	C. E. Hull, et al.	NW¼ NE¼ 23	12S	24E	B	Worked out
	Jumbo Nos. 1 and 2: See Terrill Property	W. L. Terrill					
24	Kirkland Lease		SW¼(?) 25	11S	23E	D	Disseminated. Prospects not good
15	Lacey	Eloise Edwards	NE¼ NW¼ 25	11S	23E	A	Produced more than 3,300 tons
	Lava: See Little Oak						
20	Letty	H. S. Doyle	SE¼ NE¼ 26	11S	23E	C	Mined out

6	Little Oak	Lavensaler-Speir Corporation	NE¼ NE¼ 23	11S	23E	C	Probably mined out
37	Little Rock	J. Kipp and T. C. Hole	SE¼ NE¼ 9	12S	24E	C	Mostly disseminated ore
61	Long Ledge No. 1	C. E. Hull, et al.	SE¼ NE¼ 24	12S	24E	B	Prospect for milling ore
62	Long Ledge No. 2	C. E. Hull, et al.	NW¼ SW¼ 19	12S	25E	B	Workings probably caved
63	Long Ledge No. 3	C. E. Hull, et al.	S½ SW¼ 19	12S	25E	B	Needs additional exploration
64	Long Ledge No. 4	C. E. Hull, et al.	SE¼ SW¼ 19	12S	25E	D	
	Lookout: See Brown Bird						
	Lookout: See Jack Sprat No. 5						
20	Lotty	H. S. Doyle and H. Strassbaugh	SE¼ NE¼ 26	11S	23E	C	Mined out
5	Lucky Boy	H. W. Hollingsworth	SW¼ NW¼ 24	11S	23E	C	Nodular ore
18	Manchester	H. S. Doyle and H. Strassbaugh	SE¼ NE¼ 26	11S	23E	C	Some ore left, but workings caved
18	Manchester Extension	J. W. Hazelton and H. Strassbaugh	SE¼ NE¼ 26	11S	23E	D	Prospected only
30	McMurtry	R. W. Weldon	SW¼ SE¼ and NE¼ SE¼ 4	12S	24E	B	More ore might be found with underground exploration
	Moonshine: See Powers						
	Moore Claims: See Chrome Jade Group	------	------	------	------	D	
2	Mountain Quail	Lavensaler-Speir Corporation	NW¼ NW¼ 24	11S	23E	C	A few tons of ore exposed in workings
	Nose: See Jack Sprat No. 3						
	Old Dollie	H. S. Doyle, et al.	23	11S	23E	------	Location or production not known
	Open Cut: See Jack Sprat Group						
	Partridge: See Alice						
	Pearson Property: See Long Ledge No. 2						
11	Perry Property	Bernice and F. M. Perry	NE¼ 24	11S	23E	B	Float
	Poison Oak: See Little Rock						
	Powers	George Hannemann and Bert Hammel	E½(?) 24	11S	23E	B	Location uncertain. Probably mined out
	Quien Sabe: See Chrome Gulch Group						
55	Red Slide No. 1	C. E. Hull, et al.	SW¼ NW¼ 24	12S	24E	C	
56	Red Slide No. 2	C. E. Hull, et al.	SE¼ NE¼ 23	12S	24E	B	Formerly Vance or Woodrow Wilson
	Riverview: See Long Ledge No. 2						
3	Rock Wren	H. S. Doyle/H. Strassbaugh	NW¼ NW¼ 24	11S	23E	B	
38	Rose Claims	Frank Rose	SW¼ 11	12S	24E	C	
	Rose Lease: See Long Ledge No. 3						
45	Saddle Blanket No. 1	C. E. Hull, et al.	SW¼ NE¼ 15	12S	24E	B	Possibly small reserves in each
46	Saddle Blanket No. 2	C. E. Hull, et al.	NW¼ SW¼ 14	12S	24E	B	
47	Saddle Blanket No. 3	C. E. Hull, et al.	NW¼ SW¼ 14	12S	24E	B	
48	Saddle Blanket No. 4	C. E. Hull, et al.	NW¼ SW¼ 14	12S	24E	D	Prospected only?
49	Saddle Blanket No. 5	C. E. Hull, et al.	SE¼ SW¼	12S	24E	D	Prospected only?
	Sage Hen: See Mountain Quail						

Table 3. Alphabetical list of chromite mines and prospects in Fresno County, California—Continued

Map No.	Property	Owner	Location			Class by production*	Remarks
			Section	Twp.	Range		
22	Saint	R. E. Saint	NW¼ SE¼ 25	11S	23E	B	Worked out
	Second Thought	Union Chrome Company	24	11S	23E	C	Location or production not known
	Serpentine: See Rock Wren						
	Side Kicker: See Manchester	------	------	------	------	------	Prospected only
69	Snyder Property	Vera Snyder	31	12S	24E	C	Mined out. Location uncertain
	Spike Buck: See Houghton Property						
16	Sunset	H. S. Doyle and A. A. Blasingame	SE¼ NE¼ 26	11S	23E	C	Probably mined out
	Surprise: See Saddle Blanket Group						
65, 66	Terrill Property	W. L. Terrill	18 and 19	12S	25E	C	Poor outlook
60	Thelma No. 1	C. E. Hull, et al.	NE¼ SW¼ 24	12S	24E	B	
58	Thelma No. 2	C. E. Hull, et al.	SE¼ NW¼ 24	12S	24E	C	
59	Thelma No. 3	C. E. Hull, et al.	NE¼ SW¼ 24	12S	24E	C	
	Tippecanoe: See Saddle Blanket Group						
51	Top Notch	C. E. Hull, et al.	NE¼ NE¼ 23	12S	24E	C	
**	Tromby Nos. 1 and 2	Aurora Quicksilver Company	36(?)	18S	12E	C	
	Union	H. S. Doyle, et al. (?)	?	11S	23E	------	Location or production not known
	Valley View: See Jack Sprat No 6						
	Vance: See Red Slide No. 2						
19	Victor	J. W. Hazelton and H. Strassbaugh	SE¼ NE¼ 26	11S	23E	D	Prospecting located about 1 ton of ore
14	Virginia	H. S. Doyle, et al. (?)	SE. cor. SW¼ 24	11S	23E	C	Location uncertain
	Wedge: See Saddle Blanket Group						
	Weldon Property: See Despot-Moreau Lease						
	Weldon Property: See Doyle Lease						
4	Winchester	H. S. Doyle, et al.	NW¼ NW¼ 24	11S	23E	D	2 tons mined. Poor outlook
	Wolfe: See Blue Brush						
	Woodrow Wilson: See Red Slide No. 2						
	Woods: See Long Ledge No. 2						
31	Woodworth	C. S. Woodworth	SE¼ 6	12S	24E	C	Location uncertain
23	Unidentified deposit	------	SE¼ 25	11S	23E	C	Name not known. Mined out
26	Unidentified deposit	------	NW¼ SW¼ 30	11S	23E	C	Name not known. Mined out

* A, 1,000 tons or more; B, 150-1,000 tons; C, less than 150 tons; D, no ore shipped.
** Located in western part of county.

Table 4. Alphabetical list of chromite mines and prospects in Tulare County, California

Map No.	Property	Owner	Location			Class by production*	Remarks
			Section	Twp.	Range		
2	Bowlin	Gill Bros. Cattle Company	NW cor. 20	19S	27E	C	Mined out. Flooded
6	Earl Smith	Gill Bros. Cattle Company	S½ 21 or NW¼ 28	19S	27E	B	Probably mined out
1	Gill (Gill Ranch)	Gill Bros. Cattle Company	SE¼ NW¼ 16	19S	27E	B	Mined out
7	Gill	Gill Bros. Cattle Company	NE¼ SE¼ 22	19S	27E	C	Mined out
9	Holston	Mrs. Charles Holston	S½ 9	22S	28E	A	Produced about 3,300 tons. Mined out
8	James	Mrs. J. H. James	S½ 11	21S	27E	B	Mined out
4	Sattlefield	Gill Bros. Cattle Company	NW½ 20	19S	27E	C	Location uncertain
	Vaughn: See Holston						
3,5	Waddell	Gill Bros. Cattle Company	SW¼ 17 and NW¼ 20	19S	27E	C	Mined out

* A, 1,000 tons or more; B, 150-1,000 tons; C, less than 150 tons; D, no ore shipped.

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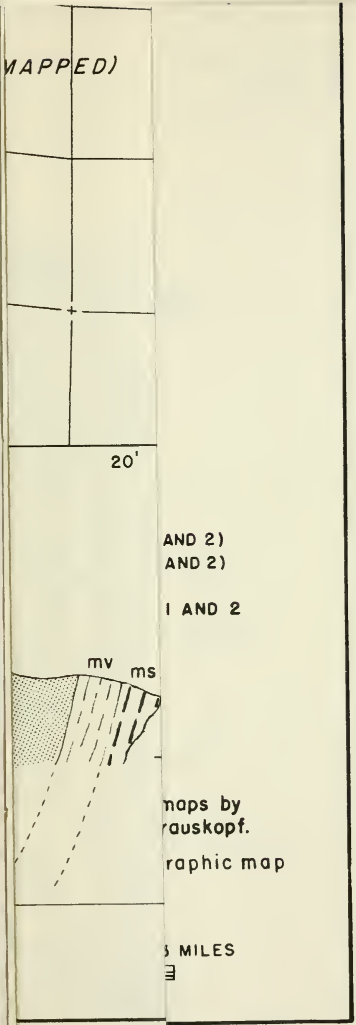
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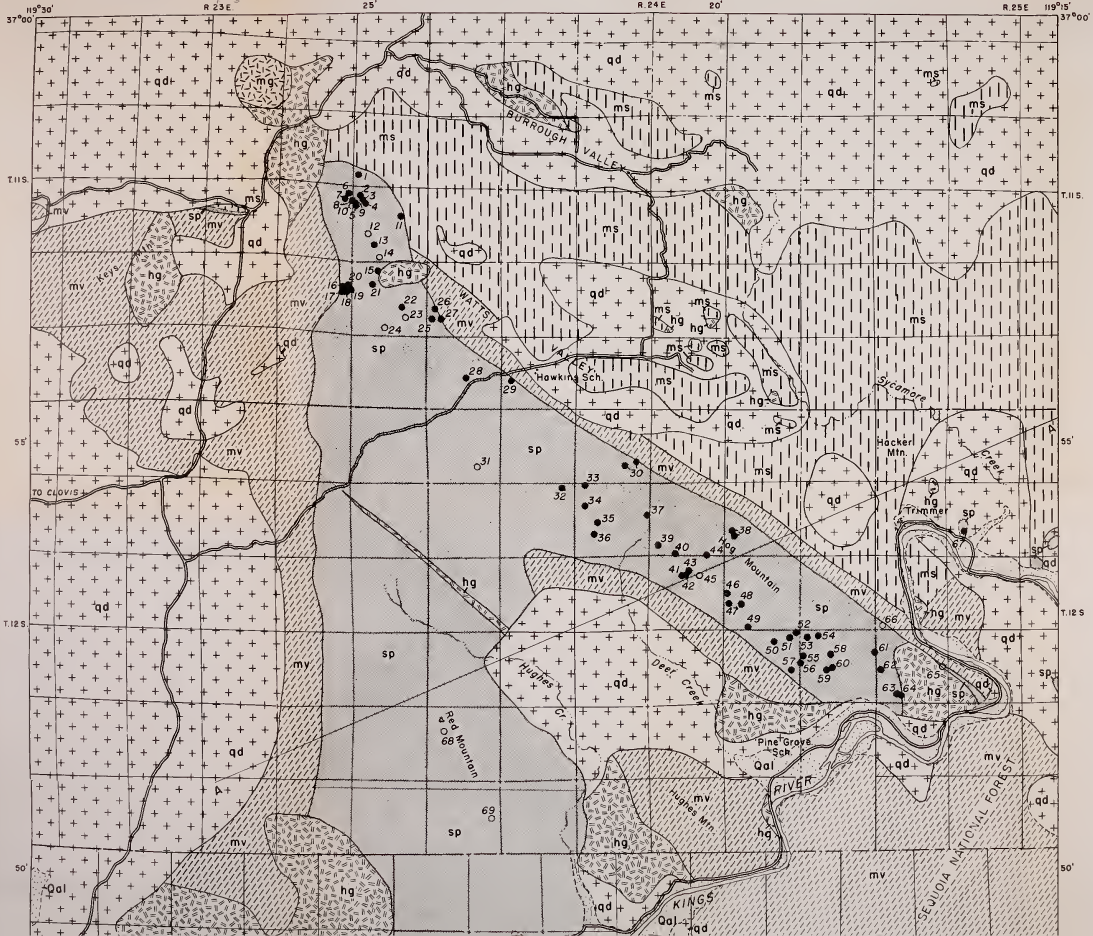


EXPLANATION

Qal | Qt

Alluvium and terrace gravels

qd | hg

Quartz diorite and hornblende gabbro

mg

Meta-gabbro

sp

Peridotite and serpentine

mv | ms

Meta-volcanic and meta-sedimentary rocks

Contact

Approximate contact

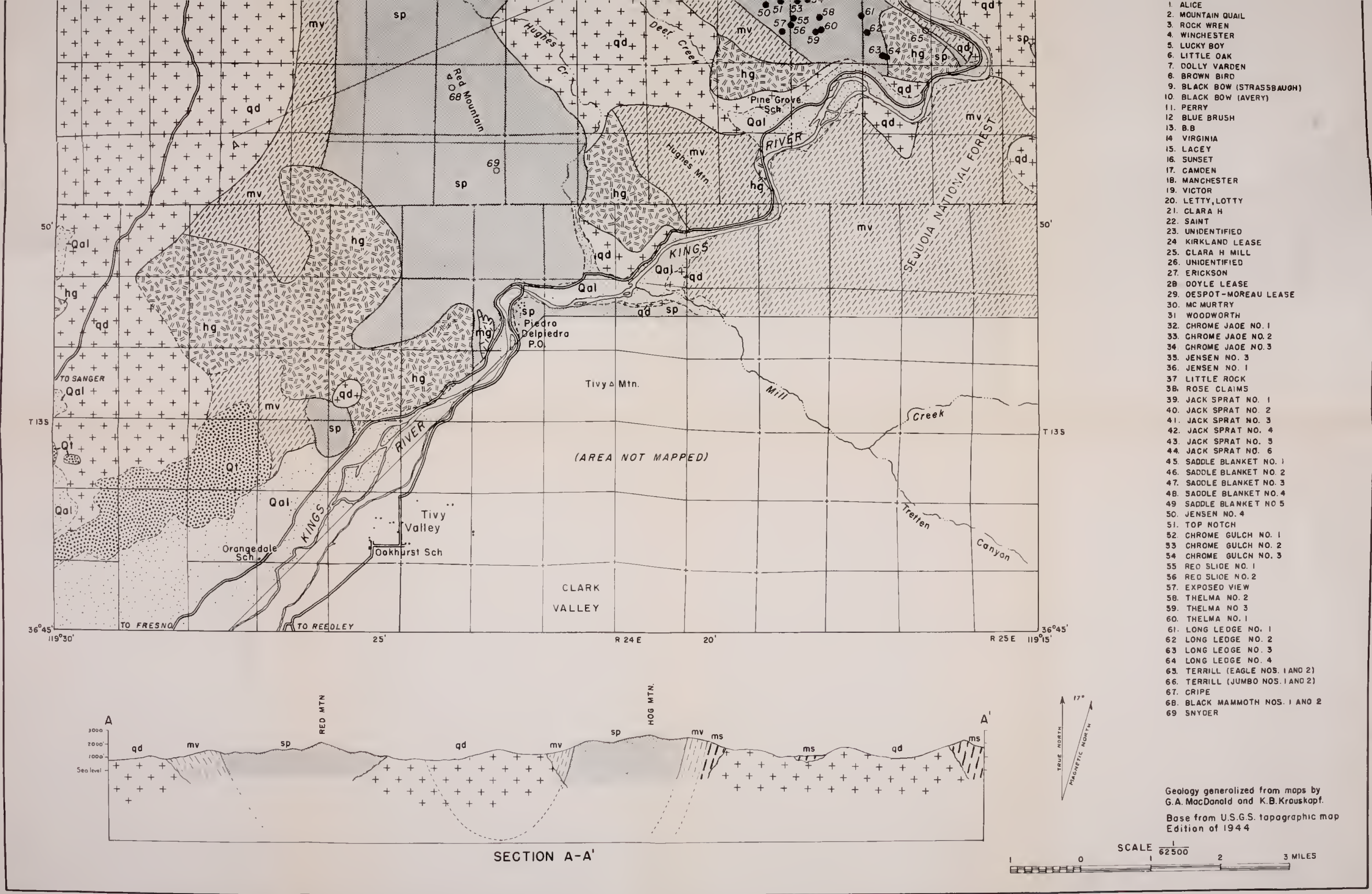
● 17
Chromite deposit definitely located

○ 66
Chromite deposit approximately located

LIST OF CHROMITE DEPOSITS

MINES AND PROSPECTS

1 ALICE
2. MOUNTAIN QUAIL
3. ROCK WREN
4. WINCHESTER
5. LUCKY BOY
6. LITTLE OAK
7. DOLLY VARDEN
8. BROWN BIRD
9. BLACK BOW (STRASSBAUGH)
10. BLACK BOW (AVERY)
11. PERRY
12. BLUE BRUSH
13. B.B.
14 VIRGINIA
15. LACEY
16. SUNSET
17. CAMDEN
18. MANCHESTER
19 VICTOR
20. LETTY, LOTTY
21. CLARA H
22. SAINT
23. UNIDENTIFIED
24 KIRKLAND LEASE
25. CLARA H MILL
26. UNIDENTIFIED
27. ERICKSON
28 DOYLE LEASE



1. ALICE
2. MOUNTAIN QUAIL
3. ROCK WREN
4. WINCHESTER
5. LUCKY BOY
6. LITTLE OAK
7. DOLLY VARDEN
8. BROWN BIRD
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23. UNIDENTIFIED
24. KIRKLAND LEASE
25. CLARA H MILL
26. UNIDENTIFIED
27. ERICKSON
28. DOYLE LEASE
29. DESPOT-MOREAU LEASE
30. MC MURTRY
31. WOODWORTH
32. CHROME JADE NO. 1
33. CHROME JADE NO. 2
34. CHROME JADE NO. 3
35. JENSEN NO. 3
36. JENSEN NO. 1
37. LITTLE ROCK
38. ROSE CLAIMS
39. JACK SPRAT NO. 1
40. JACK SPRAT NO. 2
41. JACK SPRAT NO. 3
42. JACK SPRAT NO. 4
43. JACK SPRAT NO. 5
44. JACK SPRAT NO. 6
45. SADDLE BLANKET NO. 1
46. SADDLE BLANKET NO. 2
47. SADDLE BLANKET NO. 3
48. SADDLE BLANKET NO. 4
49. SADDLE BLANKET NO 5
50. JENSEN NO. 4
51. TOP NOTCH
52. CHROME GULCH NO. 1
53. CHROME GULCH NO. 2
54. CHROME GULCH NO. 3
55. RED SLIDE NO. 1
56. RED SLIDE NO. 2
57. EXPOSED VIEW
58. THELMA NO. 2
59. THELMA NO 3
60. THELMA NO. 1
61. LONG LEDGE NO. 1
62. LONG LEDGE NO. 2
63. LONG LEDGE NO. 3
64. LONG LEDGE NO. 4
65. TERRILL (EAGLE NOS. 1 AND 2)
66. TERRILL (JUMBO NOS. 1 AND 2)
67. CRIPE
68. BLACK MAMMOTH NOS. 1 AND 2
69. SNYDER

Geology generalized from maps by G.A. MacDonald and K.B. Krauskopf.

Base from U.S.G.S. topographic map Edition of 1944

GENERALIZED GEOLOGIC MAP AND SECTION OF THE WATTS VALLEY QUADRANGLE, FRESNO COUNTY, CALIFORNIA
SHOWING LOCATION OF CHROMITE DEPOSITS

DIVISION OF MINES
OLAF P. JENKINS, CHIEF

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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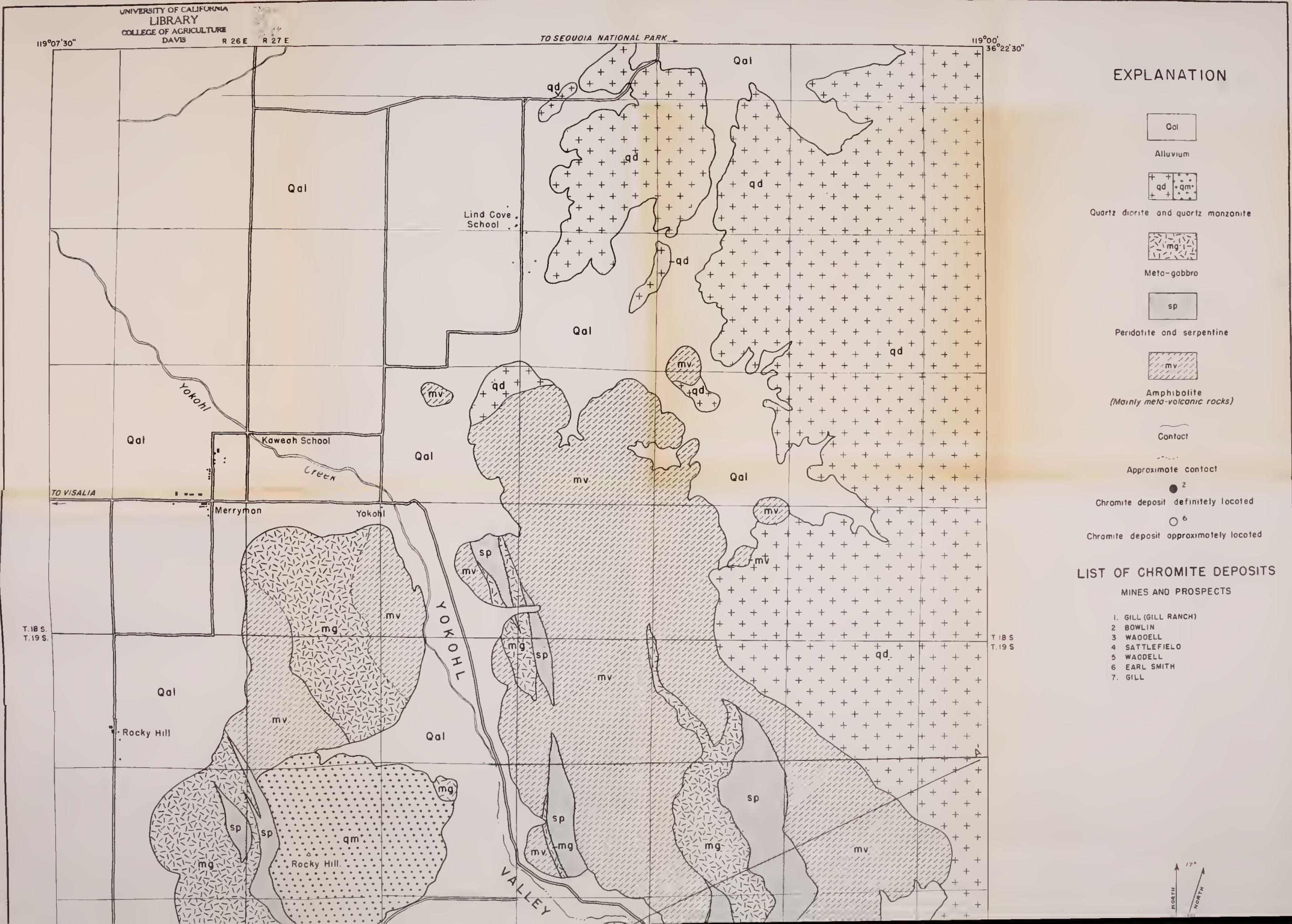
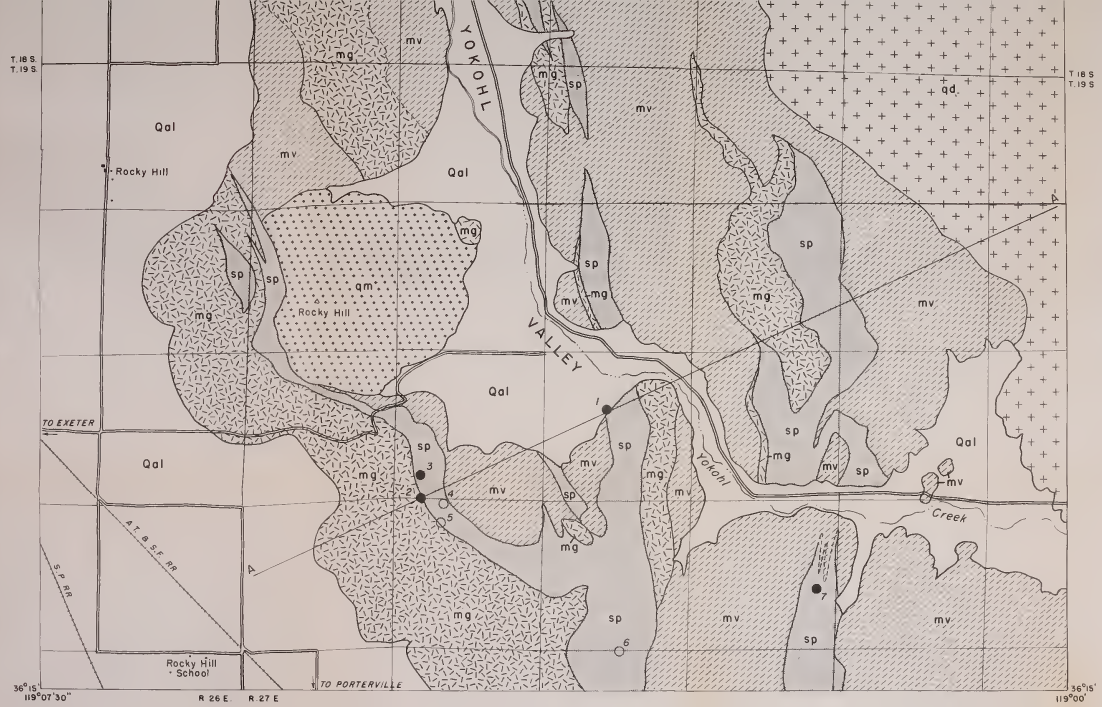


LIST OF CHROMITE DEPOSITS

MINES AND PROSPECTS

1. GILL (GILL RANCH)
2. BOWLIN
3. WADDELL
4. SATTLEFIELD
5. WADDELL
6. EARL SMITH
7. GILL



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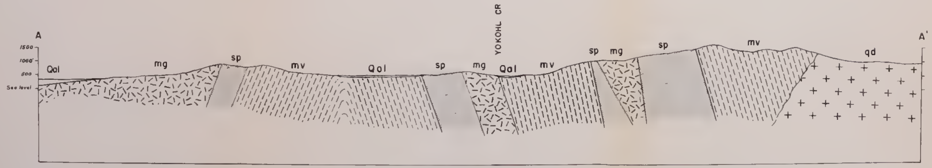

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Base from U.S.G.S. topographic
map. Edition of 1927

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SHOWING LOCATION OF CHROMITE DEPOSITS

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